PB83-174342

Quality Assurance Plan
Love Canal Study

GCA Corp.
Bedford, MA

Prepared for

Environmental Monitoring Systems Lab.
Research Triangle Park, NC

Dec 82

U.S. Department of Commerce
National Technical Information Service
NTIS

PB83-174342

EPA-600/4-82-071a
December 1982

QUALITY ASSURANCE PLAN

LOVE CANAL STUDY

LC 1-619-026

EPA CONTRACT 68-02-3168

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

Environmental Monitoring Systems Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/4-82-071a		

4. TITLE AND SUBTITLE	5. REPORT DATE
Quality Assurance Plan Love Canal Study	December 1982
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) GCA Corporation GCA/Technology Division	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS GCA Corporation Technology Division 213 Burlington Road Bedford, Massachusetts 01730	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO. 68-02-3168
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Monitoring Systems Laboratory Environmental Protection Agency Research Triangle Park, N. C. 27711	13. TYPE OF REPORT AND PERIOD COVERED Final
	14. SPONSORING AGENCY CODE EPA/600/08

15. SUPPLEMENTARY NOTES

16. ABSTRACT

The four volumes in this set comprise the working guideline documents for the Love Canal Study. The documents were developed to direct both the prime contractor and subcontractors while performing for the Environmental Protection Agency. Detailed procedures for each analysis type are described. Procedures for all field sampling are also described. Quality assurance plans submitted by each subcontractor and approved by the prime contractor are provided. A description of the document control procedure, chain-of-custody procedure, various quality control procedures, and other study operational procedures are provided.

Together the four documents provide a "work plan" for the Love Canal effort. Since the volumes were developed prior to the actual field sampling, no environmental results are included.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release Unlimited		110
	20. SECURITY CLASS *(This page)*	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

NOTICE

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

QUALITY ASSURANCE PLAN
LOVE CANAL STUDY

TABLE OF CONTENTS

Section		Page	Revision
1.1	PROJECT DESCRIPTION AND ORGANIZATION	1 of 3	1
	1.1 Project Description		
	1.2 Project Organization and Responsibility		
2.0	MAJOR PROGRAM ELEMENTS	1 of 5	1
	2.1 Sampling Plan		
	2.2 Sample Collection		
	2.3 Sample Bank		
	2.4 Sample Analysis		
	2.5 QC Sample Analysis		
	2.6 Data Handling		
3.0	QA OBJECTIVES	1 of 2	1
	3.1 Representative Sampling		
	3.2 Precision and Accuracy		
	3.3 Comparability of Results		
	3.4 GCA's Quality Assurance Program		
	3.5 Love Canal Study QA Plan		
4.0	DOCUMENT CONTROL PROCEDURES	1 of 4	1
	4.1 General Information		
	4.2 QA Project Plan		
	4.3 Project Numbering System		
5.0	CHAIN-OF-CUSTODY PROCEDURES	1 of 16	1
	5.1 General Information		
	5.2 Procedures to Ensure Validity of Sample		
	5.3 Sample Identification		
	5.4 Sample Transfer Procedures/Chain-of-Custody Records		
	5.5 Laboratory Custody Procedures		
6.0	SAMPLING INTERNAL QC CHECKS	1 of 1	1
	6.1 Air Sampling Internal QC Checks	1 of 6	1
	6.2 Meteorological Monitoring Internal QC Checks	1 of 2	1

Section		Page	Revision
6.3	Water Sampling Internal QC Checks	1 of 1	1
6.4	Soil and Sediment Sampling Internal QC Checks	1 of 1	1
6.5	Biota Sampling Equipment QC Checks	1 of 1	1
6.6	Geophysical Survey Equipment QC Checks	1 of 1	1
7.0	ANALYTICAL INTERNAL QC CHECKS	1 of 1	1
7.1	Air Monitoring	1 of 5	1
7.2	Water Monitoring	1 of 9	1
7.3	Soil and Sediment Sample Analysis	1 of 6	1
7.4	Biomonitoring Program	1 of 5	1
8.0	PRECISION AND ACCURACY	1 of 10	1
8.1	General Information		
8.2	Air Monitoring		
8.3	Water Monitoring		
8.4	Soil and Sediment Monitoring		
8.5	Dioxin Measurements - Air, Water, Soil and Sediment Samples		
8.6	Biomonitoring Program		
8.7	Precision and Accuracy Equations		
9.0	DATA MANAGEMENT SYSTEM	1 of 5	1
9.1	General Information		
9.2	Data Description		
9.3	Data Management Internal QC Checks		
10.0	SYSTEM AND PERFORMANCE AUDITS	1 of 2	1
10.1	General Information		
10.2	System Audits		
10.3	Performance Audits		
11.0	CORRECTIVE ACTION PROCEDURES	1 of 4	0
11.1	Determining the Need for Corrective Action		
11.2	Immediate Corrective Action		
11.3	Long-Term Corrective Action		

Section

Attachment 1 Sampling Subcontractor's QA Plan
Format Suggestions

Attachment 2 Analytical Subcontractor's QA Plan
Format Suggestions

Attachment 3 Geotechnical Subcontractor's QA Plan
Format Suggestions

Other parts of this QA Plan contained in separate volumes are:

Appendix A: Sampling Procedures

Appendix B: Analytical Procedures

Appendix Q: Subcontractor's QA Plan

Distribution of Love Canal Study QA Plan

Thomas Hauser, EPA-EMSL/RTP	3 copies
Steven Bromberg, EPA-EMSL/RTP	10 copies
John Puzak, EPA-EMSL-RTP	1 copy
John Clements, EPA-EMSL/RTP	1 copy
Joseph Bumgarner, EPA-EMSL/RTP	1 copy
Robert Lewis, EPA-HERL/RTP	1 copy
Randall Watts, EPA-HERL/RTP	1 copy
Robert Harless. EPA-HERL/RTP	1 copy
Roger Cosby, EPA-KERR ERL/ADA	1 copy
Craig Shew, EPA-KERR ERL/ADA	1 copy
Eugene Meier, EPA-EMSL/LV	1 copy
Stuart Black, EPA-EMSL/LV	1 copy
Kenneth Brown, EPA-EMSL/LV	1 copy
Robert Booth, EPA-EMSL/CINN	1 copy
William Budde, EPA-EMSL/CINN	1 copy
Douglas Kuehl, EPA-ERL/Duluth	1 copy
Robert Harp, EPA-NEIC/Denver	1 copy
Robert Bradway, GCA	1 copy
MaryAnn Chillingworth, GCA	1 copy
David Cogley, GCA	1 copy
Stephanie Diamond, GCA-Sample Bank	1 copy
RoseMary Ellersick, GCA	2 copies
Gary Hunt, GCA	1 copy
Mary Kozik, GCA	1 copy
Peter McGlew, GCA-Field Office	1 copy
Kenneth McGregor, GCA	1 copy
Barbara Myatt, GCA	1 copy
Timothy Porter, GCA-Field Office	1 copy
Leonard Seale, GCA	1 copy
Kenneth Wiltsee, GCA	1 copy

1.0 PROJECT DESCRIPTION AND ORGANIZATION

1.1 PROJECT DESCRIPTION

An area, called the Declaration Area, around Love Canal in Niagara Falls, New York, has been declared a Federal Emergency Area. To determine the health hazard to residents of that area the Environmental Protection Agency has designed an integrated multimedia study which includes sampling and analysis of air, water, soil, sediment and biota in the area. This information will be used in part to estimate the extent identified substances contribute to possible increased risks encountered by residents.

The air testing program includes residential monitoring to provide estimates of levels of selected air pollutants in the living environment of the residents of the Love Canal area. These estimates will be made in unoccupied homes and be used to determine the extent of the hazard in the area. A study of the extent to which selected pollutants may be transported to or from the Love Canal area by prevailing winds and the influence of nearby chemical industries will also be conducted.

The water monitoring program includes drinking water, sumps in private residences, storm and sewer drains, surface and groundwater. The groundwater measurements will be part of a hydrogeologic study to locate areas of groundwater contamination and evaluate the direction and rate of movement of contaminants.

Soils from homesites and other wet and dry areas and sediments from sewers and drains, rivers and streams will be collected for analysis. Levels of contamination in the soils and sediments will be correlated with chemical degradation information and groundwater modeling to estimate the residence time of identified pollutants.

1.2 PROJECT ORGANIZATION AND RESPONSIBILITY

GCA/Technology Division is under contract to the Environmental Protection Agency to conduct the Love Canal study described above; Steven Bromberg, EMSL/RTP, is the EPA Project Officer. In order to expedite the program in a timely manner, GCA will be conducting the sampling, analysis and geotechnical efforts through selected subcontractors under the direction of GCA senior technical staff members. GCA personnel will staff the Sample Bank in Niagara Falls and will design and implement the data management system. Figure 1.2.1 is GCA's organizational chart for the Love Canal Study; it identifies the person responsible for each major program element. Table 1.2.1 lists the subcontractors and their respective project activity.

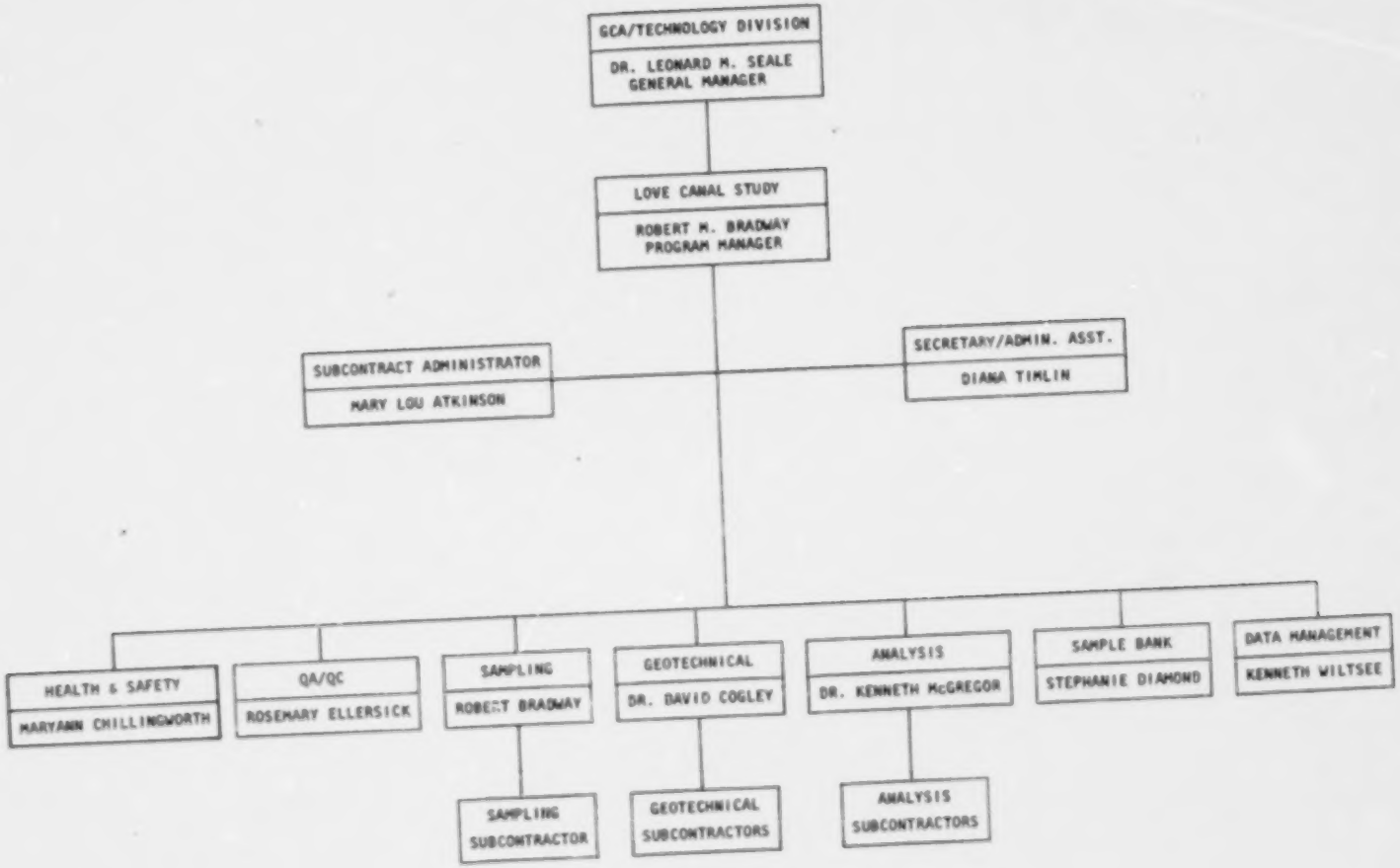


Figure 1.2.1. GCA Project Organization and Responsibility.

TABLE 1.2.1. LOVE CANAL STUDY SUBCONTRACTORS AND PROJECT ACTIVITIES

Subcontractor	Sampling/Analysis Preparation
PEDCO Environmental, Inc.	Preparation of Tenax cartridges
Southwest Research Institute	Preparation of polyurethane foam plugs
Research Triangle Institute	Spiking of Tenax cartridges
IIT Research Institute	Verification of spiked Tenax cartridges
	Sample Collection
Geomet Technologies, Inc.	All except groundwater-related
JRB Associates, Inc.	Groundwater-related
	Sample Analysis
Battelle Columbus Laboratories	Volatile organics on Tenax
PEDCO Environmental, Inc.	Volatile organics on Tenax
Gulf South Research Institute	Pesticides on polyurethane foam, organics in water, soil and sediments
Southwest Research Institute	Pesticides on polyurethane foam, soil and sediments methods study, organics in soil, sediments and biota, inorganics in water, soil, sediments and biota.
Compuchem/Mead Technology Laboratories	Organics in water, soil and sediments
PJB/Jacobs Engineering Group, Inc.	Organics in water, soil and sediments Inorganics in water, soil and sediments
TRW, Inc.	Organics in water
Acurex Corporation	Soil and sediments methods study, organics in water, soil and sediments
Energy Resources Company, Inc. (ERCO)	Inorganics in water, soil and sediments
Midwest Research Institute	Organics in biota
Wright State University	Dioxin in all media
Advanced Environmental Systems, Inc.	TOC/TOX, pH, conductivity in groundwaters
Wadley Institutes of Molecular Medicine	Interferon in mice
	Geotechnical Study
JRB Associates, Inc.	Supervisory geologist-interpretation of existing geotechnical information, coordination of drilling program, geologic logging, etc.
Empire Soils Investigations, Inc.	Well drilling
Technos, Inc.	Geophysical surveys
GeoTrans, Inc.	Geophysical modeling

2.0 MAJOR PROGRAM ELEMENTS

2.1 SAMPLING PLAN

The study area includes the region in the city of Niagara Falls, New York, bounded on the north by Niagara Falls Blvd., on the west by Cayuga Creek, on the south by the Little and Niagara Rivers, and on the east by Williams Road. This study area contains, but extends beyond, the Declaration Area.

For the purposes of this study, the area has been divided into 11 strata (subareas). The strata are based on physical boundaries, location with respect to the Canal, population patterns, and surface drainage patterns. Residences within each strata will be identified and an intensive air, water and soil monitoring program conducted in and around the homes.

EPA statisticians have checked the sampling plans to ensure that a statistically valid number of samples is collected. The air sampling protocol is based on "Quality Assurance Requirements for State and Local Air Monitoring Stations," 40 CFR 58, Subpart F, Federal Monitoring, Appendix A. Water and soil sampling is planned in conjunction with the air sampling to give a complete picture of the living environment. Ground water sampling locations will be determined from hydrologic studies conducted onsite.

In addition, a geographic grid with its origin on the Canal has been overlaid on aerial photos of the study area and will serve as the basis for random selection of sampling sites. Many sampling sites will be located at residences. Those areas devoid of homes or other living quarters will be sampled in several media at or near the center of selected grid squares.

A few samples will be obtained beyond the Declaration Area in order to gain some indication of the geographical extent of the contaminants. A mapping of all waste disposal sites and major chemical industries in the Niagara Falls area is being performed. This mapping, together with meteorologic, hydrogeologic, and other pertinent information, will be used to select control areas believed to be unaffected by contamination from the Love Canal or other major hazardous waste disposal sites. Multimedia sampling will be conducted in the control areas, and these samples will be analyzed to determine background levels.

2.2 SAMPLE COLLECTION

Samples of all media will be collected according to the EPA sampling protocol and following the sampling procedures given in Appendix A of this plan. The sampling subcontractors will maintain collected samples at 4°C and will follow the Chain-of-Custody procedures outlined in Section 5 of this plan, using the sample tags and Chain-of-Custody forms provided by GCA. Custody of the samples will be transferred to the GCA Sample Bank as soon as possible after collection and within the time limits specified in the sampling procedures.

Close communication will be maintained between the subcontractor's onsite QA project coordinator and GCA QA/QC personnel, both onsite and in Bedford, Massachusetts. The onsite interaction will be particularly valuable in initiating and completing corrective action.

2.3 SAMPLE BANK

The Sample Bank operation is being managed and staffed by GCA personnel. Chain-of-Custody documents will be dispensed from the Sample Bank, and Custody records, from preparation of collection media through shipment of the collected samples to analytical laboratories, will be maintained at the bank by the Document Control Officer (DCO).

Air collection media (Tenax tubes, polyurethane foam modules and Hi-Vol filters) will be received from the preparing laboratories and dispensed to the sampling subcontractor at the Sample Bank. QC samples, such as performance evaluation samples and spiked air collection media, will be received at the Sample Bank from EPA or other preparing laboratories and inserted in the sample groupings to be shipped to analytical subcontractors.

Collected samples will be accepted at the Sample Bank and logged into a Master Log. Due to the complexity of this program, four separate Master Logs will be maintained, one each for air samples, water samples, soil and sediment samples, and biota and other samples. Since each sample will be assigned a new Sample Bank number and sample tag, it will be possible to submit duplicate samples and spiked air collection media to analytical laboratories as blind QC samples, indistinguishable from collected samples.

Most samples require storage and shipment at 4°C; this will be accomplished through use of the large, refrigerated storage area of the Sample Bank and the use of insulated shipping containers with cold-pack refrigerants. Temperature-indicating devices will be included in each container to establish that a temperature of 4°C or lower was maintained during shipment.

Sample Bank personnel will arrange prompt shipment, usually by Federal Express, to the appropriate analytical laboratories, and they will notify the laboratory as to the expected date and delivery time of each shipment. Figure 2.3.1 shows both the physical sample transfer into and out of the Sample Bank and the associated data flow.

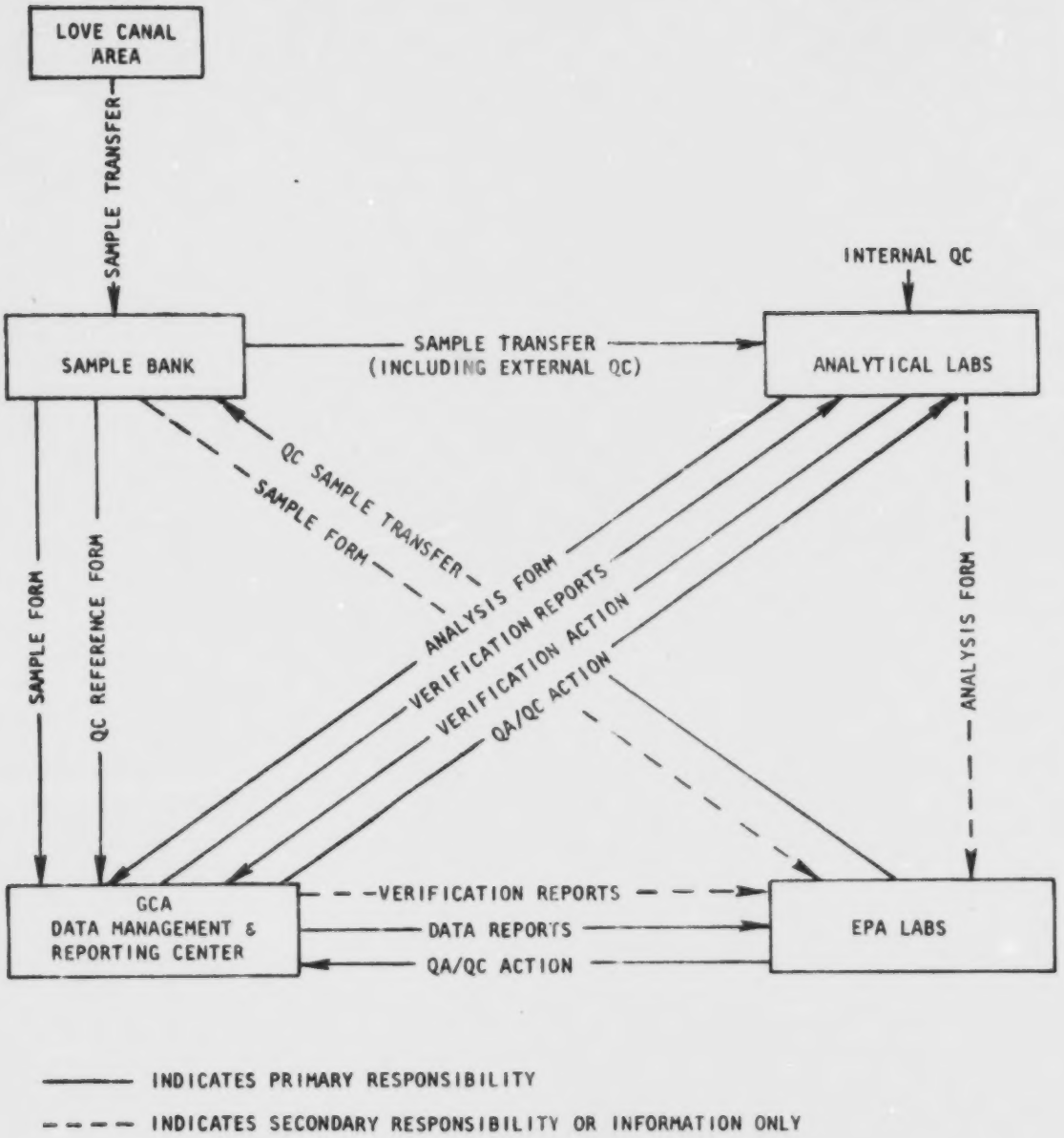


Figure 2.3.1. Sample Transfer and Data Flow.

2.4 SAMPLE ANALYSIS

The large numbers of complex analyses required for this program will be performed by the subcontractors listed in Table 1.2.1 and the following EPA laboratories:

EMSL, Research Triangle Park	Metals on Hi-Vol filters
EMSL, Las Vegas	Radioactivity
ERL, ADA	Well Cores

GCA will oversee the subcontracting laboratories' work with special attention given to QC sample results, on-time completion of analyses and prompt submission of data. Close communication with the QA Project Coordinator at each laboratory will be maintained to monitor performance and determine if instrument downtime or other problems are preventing the anticipated throughput of samples. The Sample Bank will be notified promptly, throughout the program, of any changes in the sample shipping plan based on the above criteria.

The analytical laboratories are responsible for notifying the Sample Bank of sample receipt and maintaining Chain-of-Custody records from receipt of the samples until completion of analytical work and transfer of all test data to GCA. In selected cases, sample extracts are to be preserved and returned with data.

2.5 QC SAMPLE ANALYSIS

EPA Laboratories will analyze replicate collected samples as noted below to establish interlaboratory precision.

- EMSL, Research Triangle Park — Tenax Air Samples
- HERL, Research Triangle Park — Foam Air Samples, Dioxin Samples
- EMSL, Research Triangle Park — Hi-Vol filters
- EMSL, Cincinnati — Water, Soil, Sediment Samples
- ERL, Duluth — Organics in Biota Samples
- ERL, Corvallis — Inorganics in Biota Samples

2.6 DATA HANDLING

GCA will provide standardized sampling and analytical data reporting forms which are designed in an 80-column format for direct keypunching of reported information. The reporting forms for sampling data will be coded at the Sample Bank so that all appropriate sample tag numbers and Chain-of-Custody record numbers are entered. Each analytical laboratory will encode its own data and transmit the coding forms to GCA and the specified EPA laboratory.

The flow of data among the various parties involved in the study is presented in Figure 2.3.1. This figure describes both the transfer of actual samples (referred to as "sample transfer" on the figure) and the flow of sample information (all other lines in Figure 2.3.1).

EPA laboratories will receive data reports based on their areas of interest as follows:

- EMSL, Research Triangle Park — Air (Tenax, Hi-Vols)
- HERL, Research Triangle Park — Air (Foam), Dioxin in all media
- EMSL, Las Vegas — Water, Soil/Sediment, Biota
- ERL, ADA — Groundwater

All validated data will ultimately be transferred to Research Triangle Park for detailed data analysis.

3.0 QA OBJECTIVES

The objective of the GCA/Technology Division contract efforts in this program is to collect representative multimedia samples which can then be analyzed in a precision and accurate fashion with results reported in standard, comparable formats.

3.1 REPRESENTATIVE SAMPLING

EPA has designed the sampling protocol to collect a statistically valid number and geographical distribution of samples; the sampling subcontractors are responsible for collecting samples representative of the media sampled. The sampling procedures, included as Appendix A of this volume, provide the necessary guidelines for the conduct of the sampling program.

3.2 PRECISION AND ACCURACY

The QA objective is to achieve the precision and accuracy criteria stated in the analytical methods as contained in Appendix B of this plan. This may not be possible in all cases since the collected samples may contain interferences, and the analysis scheme is a complex one. The analytical subcontractors have been provided with all sections of Appendix B appropriate to their work and will report the precision and accuracy they achieve.

3.3 COMPARABILITY OF RESULTS

The measures taken to ensure comparability of analytical work performed by different subcontractors include the use of:

- Standardized written sampling and analysis procedures.
- Tenax cartridges prepared by one laboratory from one lot of Tenax.
- Polyurethane foam plugs cut from one lot and prepared by one laboratory.
- Tenax calibration standard cartridges prepared by one laboratory.
- Pesticide and related chemical standards from the same lot.
- Standardized field and analytical data sheets, and sample identification tags.

- All external QC samples of one type provided by one source.
- Standard handling and shipping procedures for all collected samples.

3.4 GCA'S QUALITY ASSURANCE PROGRAM

GCA/Technology Division management is fully committed to an effective Quality Assurance/Quality Control program whose objective is the delivery of a quality product. The program includes a division QA/QC committee, individual department QC committees, QA/QC manuals, specific QA Project Plans, QA/QC personnel training and corrective action procedures.

The division QA Manager is a full-time professional who reports directly to the General Manager and coordinates and directs the overall quality program with strong management support. The division QA Manager is the QA Coordinator for the Love Canal Study.

3.5 LOVE CANAL STUDY QA PLAN

The overall QA Project Plan is contained in this volume and the following appendices:

Appendix A: Sampling Procedures
Appendix B: Analytical Procedures
Appendix Q: Subcontractors' QA Plans

All four volumes will be distributed to EPA and GCA project personnel as identified on the distribution lists at the end of the Table of Contents in each volume. The Sampling and Analytical Procedures Manuals include the internal QC requirements specified by EPA and have been provided to the sampling and analysis subcontractors as appropriate.

Each subcontractor is required to submit to GCA a QA Plan specific to his project activity. Attachments 1-3 to this plan present the information submitted to the sampling, analysis and geotechnical subcontractors as guidance in developing their QA Plans. The attachments include format suggestions and suggested QA Plan outlines.

Document Control and Chain-of-Custody procedure writeups were also provided to the subcontractors. Each subcontractor's QA Plan will be reviewed, revised if necessary, approved by GCA subject to final EPA approval, and incorporated in its entirety in Appendix Q to the overall QA Plan. GCA will extract the appropriate project-specific information from each subcontractor's plan and integrate it in this volume to compile a document which is easier to review than the plan with all subcontractor plans included. The appropriate sections of the QA Plan will be revised to effect this incorporation and all revisions will be provided to the distribution list under document control procedures. The QA Plan will be originally distributed in ring binders to enable easy updating of sections.

4.0 DOCUMENT CONTROL PROCEDURES

4.1 GENERAL INFORMATION

The purpose of document control is to ensure that all project documents will be accounted for when the project is complete. Table 4.1.1 lists the principal items subject to document control with records maintained by the person listed as Document Control Officer (DCO) for that document. Table 4.1.2 gives a more complete listing of documents generated during the project. GCA will provide a DCO onsite at the Sample Bank who will maintain overall document control for all items passing through the Sample Bank.

Each subcontractor shall identify a DCO for its operations who will be responsible for issuing, controlling and maintaining records of controlled documents. At the conclusion of subcontract activity, all controlled documents with records shall be provided to GCA for inclusion in an overall project document inventory.

Procedures described in Section IX of "Enforcement Considerations for Evaluations of Uncontrolled Hazardous Waste Disposal Sites by Contractors," Environmental Protection Agency, National Enforcement Investigations Center, Denver, Colorado, April 1980, shall be followed.

4.2 QA PROJECT PLAN

Each page will contain a heading on the upper right-hand corner that indicates Section Number, Revision Number, and Page Number of Total Pages in the section. The appropriate document numbering for subcontractor QA Plans has been provided by the GCA QA Manager. When a revision to a QA Plan is made, the Table of Contents will be retyped to show the most current revision of each section, and both the revision and the revised Table of Contents will be distributed to all recipients of the original QA Plan. These recipients will be listed at the end of the QA Plan Table of Contents and in the QA Manager's records.

4.3 PROJECT NUMBERING SYSTEM

4.3.1 Project Code

The project code for the Love Canal Study is LC 1-619-026; this number must appear on sample identification tags, custody records, logbooks, data sheets, control charts, project memos and reports, document control logs, corrective action forms and logs, QA Plans, and all other project records.

TABLE 4.1.1. DOCUMENT CONTROL REQUIREMENTS

Item	Issued by	Numbering	Interim responsibility	DCO
Sample Collection Tags	Sample Bank	Preserialized	Sampling Subcontractor	GCA Sample Bank
Custody Records	Sample Bank	Preserialized	See Section 5.0	See Section 5.0
Field Logbooks	Sample Bank	LC 1-619-026-	Sampling Subcontractor	Sampling Subcontractor
Field Data Sheets	Sample Bank	LC 1-619-026-	Sampling Subcontractor	GCA Sample Bank
Written Communication	Various People	Number and page of personal notebook where item is cited	Recipient	Subcontractor
Photos or Drawings	Originator		Originator	Subcontractor
Analytical Sample Tags	Sample Bank	Preserialized	GCA Sample Bank	Analytical Subcontractor
Laboratory Notebooks	Subcontractor	LC 1-619-026-	Analytical Subcontractor	Analytical Subcontractor
Analytical Data Sheets	GCA	LC 1-619-026-	Analytical Subcontractor	Analytical Subcontractor
QA Project Plan	GCA	Section, Revision, Page Number of Total Pages	GCA QA Manager	GCA QA Manager
QA Project Plans	Subcontractors		Subcontractors	

TABLE 4.1.2. SUGGESTED DOCUMENT CODES

Document	Code Letter
Project Work Plans	A
Project Logbooks	B
Sampling Logbooks	C
Sampling Data Sheets	D1, D2 etc.
Sampling Coding Form	E
Laboratory Notebooks	G
Laboratory Data Sheets	H1, H2 etc.
Laboratory Coding Form	J1, J2 etc.
Sample Logs	L1, L2 etc.
Internal Memos	M
External Written Communication	N
Confidential Information	O
Photos, Maps, Drawings	P
QA Plan	Q
Reports	R
Final Report	FR
Miscellaneous	X

4.3.2 Preserialized Documents

Sample collection and analytical tags, and custody records have preprinted serial numbers on them. It is not necessary that a tag number match a custody record number; it is necessary that each subcontractor DCO maintain records which account for all serially numbered items received. If tags or custody records are damaged, lost or destroyed before use for their intended purpose, the serial number of the item and its disposition must be recorded.

4.3.3 Other Documents

Sample identification tags and custody records are accounted for by their preserialized numbers. Other documents use the following numbering scheme to enable unique identification of each item:

Project Code	Subcontractor Code	Document Code	Serial Number
LC 1-619-026-	-00-	-A-	-00001

Table 4.1.2 presents a suggested document code. Each subcontractor's DCO will finalize the system to be used for their documents; it is desirable that consistent document codes be used by all subcontractors to facilitate compiling the overall project document inventory.

5.0 CHAIN-OF-CUSTODY PROCEDURES

5.1 GENERAL INFORMATION

The procedures identified here have been established for this project by the GCA QA Manager working with NEIC staff members and following guidelines developed from the following two publications:

- NEIC Policies and Procedures Manual, EPA-330/9-78-001R, Section II.
- Enforcement Considerations for Evaluations of Uncontrolled Hazardous Waste Disposal Sites by Contractors, NEIC, April 1980, Section VIII and IX.

The purpose of chain-of-custody procedures is to document the identity of the sample, and its handling, from its first existence as a sample until information derived from it is introduced as evidence during an enforcement proceeding. Custody records trace a sample from its collection through all transfers of custody until it is transferred to an analytical laboratory. Internal laboratory records then document the custody of the sample through its final disposition.

In order to establish that a sample is valid, it is also necessary to document the measures taken to prevent and/or detect tampering--either to the sample itself, the sampling equipment used or the environment sampled. This is done by the use of evidence tape, locks and custody seals, and documented entries noting their condition in field and laboratory log books. The custody record must document any tampering that may have occurred; the absence of any such comments indicates no tampering observed or noticed during the period of custody.

The GCA Sample Bank will provide and dispense evidence tape, sample tags, custody records, logbooks, field data sheets, custody seals and locks as appropriate. Custody procedures are presented here in considerable detail so that they may be uniformly followed.

The sampling subcontractor shall identify an onsite person responsible for ensuring that custody procedures are followed and for referring any tampering cases or other questions to GCA's onsite QA coordinator who is responsible for custody procedures. Analytical subcontractors shall also identify a person responsible for custody matters.

5.2 PROCEDURES TO ENSURE VALIDITY OF SAMPLE

5.2.1 Houses to be Sampled

It is necessary that all houses be unoccupied for the duration of the sampling period, and that the homeowner, through EPA, will provide keys to the house. Evidence tape, plastic, perforated tape used by police departments, will be supplied by the GCA Sample Bank. Custody seals may also be used. The following procedures shall be followed and documented in the field log book:

Prior to sampling:

- Windows — Close securely with existing lock. Place strip of evidence tape on inside of each window so that it cannot be opened without ripping tape.

- Doors and other entries — Close securely with existing lock. Determine which entry will be used by the sampling team on a routine basis. Place strip of evidence tape on inside of other entries so they cannot be opened without ripping tape. Place strip of evidence tape on outside of sampling team entry door when leaving.

Succeeding sampling days:

- Document condition of tape on entry door.

- Enter house and document condition of inside-taped areas.

- If all tape is unripped, proceed with sampling. If tape is ripped, see Section 5.2.3.

- When leaving house even for a short time, tape the entry door on the outside.

- Document anytime evidence tape is removed or changed in anyway.

5.2.2 Sampling Equipment

The sampling subcontractor must have documented proof that equipment has not been tampered with before, during and after sample collection. In many cases, this may be accomplished by placing strips of evidence tape on equipment storage boxes and storage rooms to demonstrate security of stored equipment. Outdoor samplers, such as Hi-Vols, may require fenced enclosures.

During sample collection:

- Do not use tape on samplers collecting volatile or semivolatile organic samples because of possible contamination from the plastic or the adhesive. Tape on doors or windows is not expected to cause measurable contamination.

- If a sampling team member will be present, no other measures are needed.
- If equipment is in a house that has not been tampered with during collection, it may be assumed that tampering of the equipment has not occurred.
- Use tape on unattended samplers in such a way that it would be ripped by tampering.

5.2.3 If Tampering is Suspected

If tape is ripped, document the situation including a judgment as to whether tampering was involved. Do not proceed with sampling until responsible subcontractor personnel and the GCA onsite QA coordinator have been notified and GCA or EPA states that sampling should proceed for that day. Determine whether more stringent measures, such as locks or a guard, should be employed in the future at that site.

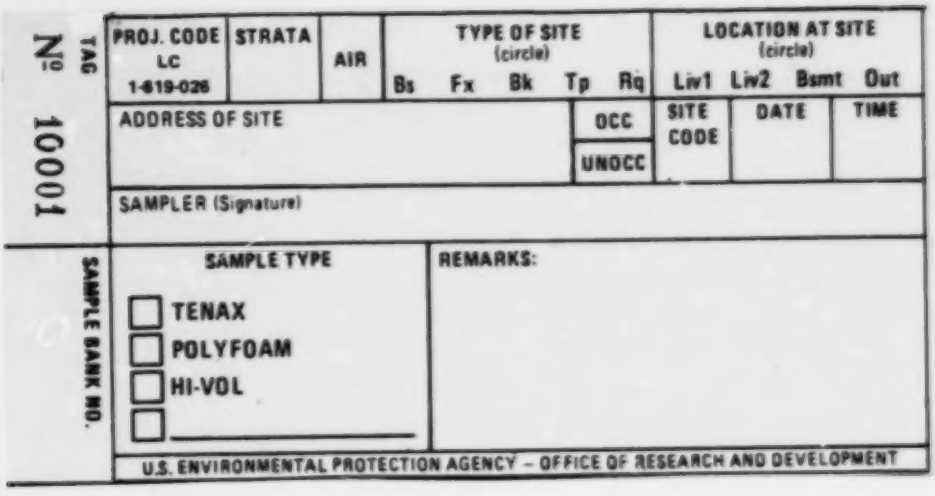
5.3 SAMPLE IDENTIFICATION

Sample collection tags have been designed for air, water, soil and sediment, and biota or other samples and are shown in Figures 5.3.1 and 5.3.2. They are a different color for each media and are serially numbered starting with different blocks of numbers for each media. The tags are preprinted to ensure that the required information is provided on each tag. Each collected sample, including duplicates and field blanks, shall have a completely filled-in sample tag securely attached to it. Duplicates and field blanks shall be so identified in the "Remarks" section of the tag.

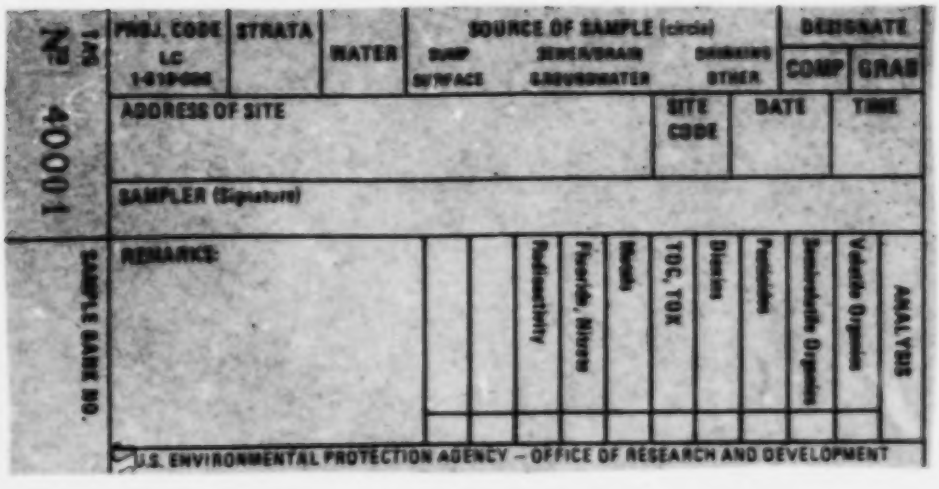
The person who physically collects the sample is the SAMPLER and signs the sample tag. He may presign the tag if he will be in hazardous conditions when sampling. Another member of the team may enter the exact time of sample collection; all team members present shall be recorded in the logbook. The SAMPLER initiates the custody record for transfer of samples to the Sample Bank.

After the collected samples have been transferred to the Sample Bank and documented there, they will be renumbered and identified with a new sample analysis tag for shipment to analytical laboratories. This renumbering step enables the submittal of duplicate samples and QC samples as blinds to the analytical laboratory. The same analysis tag (Figure 5.3.3) is used for all samples; it is a different color and numbered with a block of numbers different from other tags.

The original sample collection tag number is recorded in the master log and the tag itself is stored in the document file at the Sample Bank. An important aspect of sample identification traceability is the system of cross-indexing logbooks maintained at the Sample Bank and the computer file which can correlate any one of the identifying numbers with a specific sample. These numbers include those found on the:

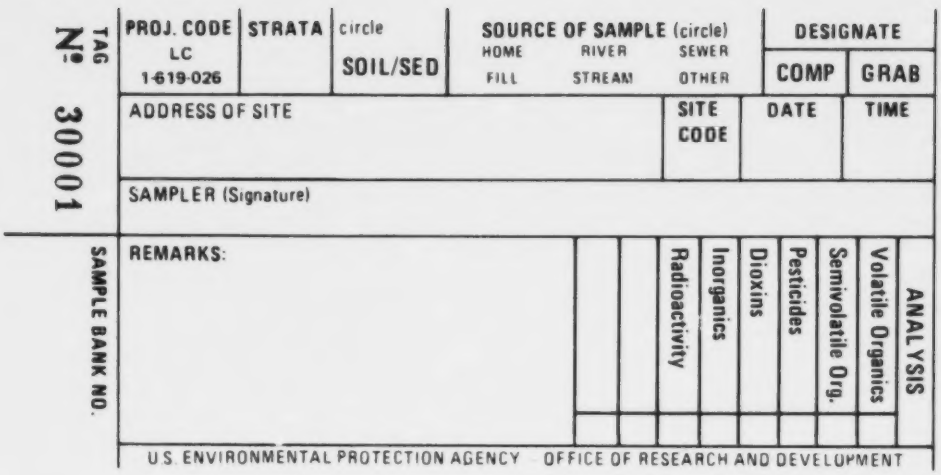


AIR SAMPLE TAG

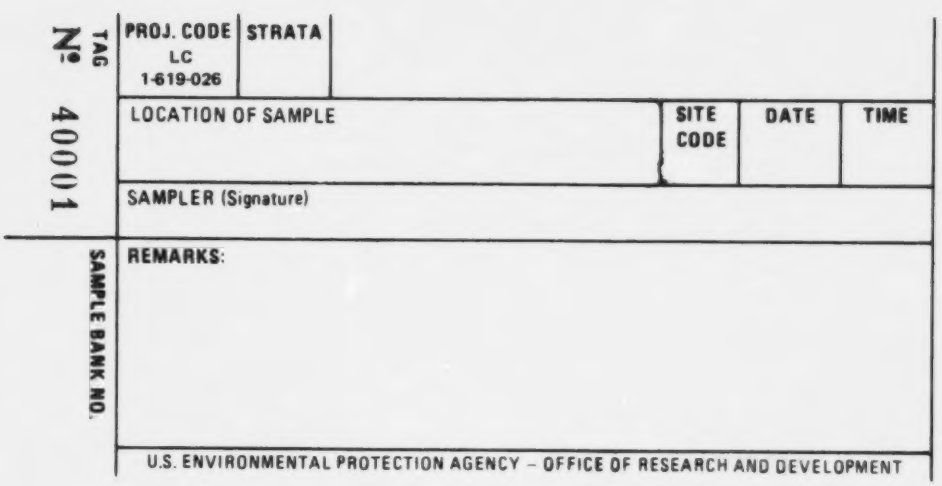


WATER SAMPLE TAG

Figure 5.3.1. Sample collection tags.



SOIL/SEDIMENT SAMPLE TAG



BIOTA/OTHER SAMPLE TAG

Figure 5.3.2. Sample collection tags.

PROJ. CODE	SAMPLE BANK NO.
LC 1-619-026	

SAMPLE DESCRIPTION

ANALYSIS	
Volatile Organics	
Semivolatile Org.	
Pesticides	
Dioxins	
TOC, TOX	
Metals	
TSP	
Fluoride, Nitrate	
Radioactivity	

TAG Nº 60001

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT

Figure 5.3.3. Analysis tag.

- Sample Collection Tag
- Custody Record transferring custody to the Sample Bank
- Sample Bank Master Log
- Analytical Sample Tag
- Custody Record transferring custody to the Analytical Laboratory.

5.4 SAMPLE TRANSFER PROCEDURES/CHAIN-OF-CUSTODY RECORDS

There are many transfers of custody in this program since materials are shipped to the Sample Bank for distribution to the sampling team or inclusion with collected samples, and shipped from the Sample Bank to analytical laboratories. The collection medium used for air sampling becomes part of the sample itself after collection; therefore, the laboratory preparing Tenax cartridges or polyurethane foam plugs must initiate a custody record and include it with their shipment of Tenax or foam. Laboratories providing QC samples must also initiate a custody record. Secure shipping procedures described in Section 5.4.5 should be followed for all shipments.

5.4.1 Chain-of-Custody Record Sheets

Customized record sheets, following the NEIC format. have been provided for this program and are shown as pages 8 through 13 of this section. Pages 8 and 9 are used for shipping collection media and QC samples to the Sample Bank; pages 10 through 12 are used for samples collected in the field; and page 13 is used for all shipping of samples to analytical laboratories. They are two-part carbonless copy forms which correlate with the sample identification tags; requested information has the same heading on both.

The custody records are used for a packaged lot of samples; more than one sample will usually be recorded on one form. More than one custody record sheet may be used for one package, if necessary. Their purpose is to document the transfer of a group of samples traveling together; when the group of samples changes, a new custody record is initiated. The original of the custody record always travels with the samples; the initiator of the record keeps the copy. When custody of the same group of samples changes hands several times, some people will not have a copy of the custody record. This is acceptable as long as the original custody record shows that each person who had received custody has properly relinquished it.

5.4.2 Using the Custody Record Sheet

- The originator fills in all requested information from the sample tags (except in the case of air collection media and external QC samples).

- The person receiving custody checks the sample tag information against the custody record. He also checks sample condition and notes anything unusual under "Remarks" on the custody form.

ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development

CHAIN OF CUSTODY RECORD

COLLECTION MEDIA

Project Code	Project Name
LC	LOVE CANAL STUDY (1-619-625)

PREPARING LAB:

Lot No.	Date Prepared	Unit Identification	No. of Units	COLLECTION MEDIUM: Tenax Cartridge	Polyfoam Plug	Hi-Vol Filter	REMARKS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	

№ 1000 Distribution: Original Accompanies Shipment; Copy to Originator Files

22

ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development

CHAIN OF CUSTODY RECORD

QC SAMPLES

Project Code	Project Name
LC	LOVE CANAL STUDY (1-619-026)

TO: SAMPLE BANK

SAMPLE DESCRIPTION							ANALYSIS										
Tag No.	Tenax	Polyfoam	Hi-Vol	Water	Soil	Sediment	Other	Volatile Organics	Semivolatile Organics	Pesticides	Dioxins	TOC, TOX	Metals	TSP	Fluoride, Nitrate	Radioactivity	REMARKS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Sample Bank by: (Signature)	Date/Time	Remarks	

Nº 6000 Distribution: Original Accompanies Shipment; Copy to Originator Files

ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development

CHAIN OF CUSTODY RECORD

AIR SAMPLES

Project Code	Project Name
LC	LOVE CANAL STUDY (1-619-826)

SAMPLERS (Signature)

Tag No.	Stock	Type of Site	Location of Site	Date	Site Address	SAMPLE TYPE: Tenax Cartridge	SAMPLE TYPE: Polyfoam Plug	SAMPLE TYPE: Hi-Vol Filter	REMARKS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Sample Bank by: (Signature)	Date/Time	Remarks	

№ 7000 Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development

CHAIN OF CUSTODY RECORD

WATER/SOIL/SEDIMENT

Project Code	Project Name
LC	LOVE CANAL STUDY (1-619-026)

SAMPLERS (Signature)

Tag No.	Strata	Water	Soil	Sed.	Source of Sample	Comp.	Grab	Date	Site Address	ANALYSIS: Volatile Organics	Semivolatile Organics	Pesticides	Dioxins	TOC, TOX	Metals	Fluoride, Nitrate	Radioactivity	REMARKS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Sample Bank by: (Signature)	Date/Time	Remarks	

Nº 4000 Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development

CHAIN OF CUSTODY RECORD
BIOTA AND OTHER

Project Code	Project Name
LC	LOVE CANAL STUDY (1-619-026)

SAMPLERS (Signature)

REMARKS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	

Nº 001 Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development

CHAIN OF CUSTODY RECORD

Project Code	Project Name
LC	LOVE CANAL STUDY (1-619-026)

TO:

Sample Bank No.	SAMPLE DESCRIPTION							ANALYSIS										REMARKS
	Tenax	Polyfoam	Hi-Vol	Water	Soil	Sediment	Other	Volatile Organics	Semivolatile Organics	Pesticides	Dioxins	TOC, TOX	Metals	TSP	Fluoride, Nitrate	Radioactivity		

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	

№ 2000 Distribution: Original Accompanies Shipment; Copy to Sample Bank Files

- The originator signs in the top left "Relinquished by" box and keeps the copy.
- The person receiving custody signs in the adjacent "Received by" box and keeps the original.
- The Date/Time will be the same for both signatures since custody must be transferred to another person.
- When custody is transferred to the Sample Bank or an analytical laboratory, blank signature spaces may be left and the customized last "Received by" signature box used. Another approach is to run a line through the unused signature boxes.
- In all cases, it must be readily seen that the same person receiving custody has relinquished it to the next custodian.
- If samples are left unattended or a person refuses to sign, this must be documented and explained on the custody record.

5.4.3 Chain-of-Custody Forms Used for a Volatile Organic Air Sample

An air sample is used for example because it requires several different custody forms.

Collection Media (page 8)

- Initiated by Tenax preparing lab which keeps copy.
- Custody transferred to Sample Bank.
- Custody transferred to subcontractor's sampling team member.

If the whole lot received by the Sample Bank is transferred to the sampling team, one custody record is used throughout; the sampling team keeps the original. If only part of the original received lot is transferred, a new Collection Media Custody form is initiated by the Sample Bank which keeps the copy. The sampling team keeps the original.

Collected Air Samples (page 10)

- Initiated by sampling team member who keeps copy.
- Custody transferred to Sample Bank which keeps original and maintains internal custody procedures.
- Samples recorded in Master Log, QC samples included, and Sample Bank numbers assigned. New sample analysis tags attached and original sample collection tags filed at Sample Bank.

Analytical Samples (page 13)

- Initiated by Sample Bank.
- Custody relinquished by shipper, GCA Sample Bank, before packing the original of custody form in with the samples.
- Sample Bank keeps copy of custody form and all shipping papers, bill of lading, etc.
- Custody transferred to analytical lab which keeps original record.
- Analytical Lab Document Control Officer maintains original custody record until transmittal of complete project document inventory to GCA at completion of project activity.

5.4.4 Questions/Problems Concerning Custody Records

If a discrepancy between sample tag numbers and custody record listings is found, the person receiving custody should document this and properly store the samples. The samples should not be analyzed until the problem is resolved by contacting the GCA QA Manager or other designated responsible authority.

The responsible person receiving custody should attempt to resolve the problem by checking all available information (other markings on sample container, type of sample, etc.). He should then document the situation on the custody record and in his project logbook and notify the GCA QA Manager by the fastest available means, followed by written notification.

Changes may be written in the "Remarks" section of the Custody record and should be initialed and dated. A copy of this record should accompany the written notification to the QA Manager.

5.4.5 Custody Seals

Custody seals are narrow strips of adhesive paper used to demonstrate that no tampering has occurred. They may be used on sampling equipment or a house door, but they are intended for use on a sample transport container which is not secured by a padlock. They are not intended for use on individual sample containers.

5.4.6 Custody of Shipped Samples

When a group of samples with its custody form is to be shipped, the shipper (e.g., GCA) accompanies the package to the carrier (e.g., Federal Express) so that, if requested, the number and identification of the samples in the container can be verified. The commercial carrier is not required to verify this.

The package is then closed with a strong, keyed padlock of strapping tape and custody seals so that the carrier is transporting a secure container.

NEIC's recommended procedure for custody seal use on shipping boxes is as follows:

- Place paper side of seal against box and wrap strapping tape across the middle of the seal and at least twice around the box.
- Cut the tape so that the ends overlap at the seal.
- Fold the seal to itself over this overlap and sign the custody seal.
- Repeat this procedure as many times as necessary to seal the box for shipment.

The person receiving custody of shipped samples must document the condition of the locked, or strapped and sealed shipping box on arrival. It must be checked that neither the tape or the custody seals has been cut or otherwise tampered with. If the paper seal has been damaged in shipping but it is clear that the shipping box has not been opened, further handling of the samples may proceed. If tampering is suspected, the designated Sample Custodian shall notify the GCA Sample Bank.

5.5 LABORATORY CUSTODY PROCEDURES

The Sample Bank, the sampling subcontractor's laboratory area, and each subcontracting analytical laboratory are considered to be working laboratories. Each laboratory shall have a designated Sample Custodian who implements a system to maintain control of samples. It is assumed that the laboratory is not open to the general public but has access restricted to employees known to each other. Each handling of the sample to renumber, subdivide, preserve, etc. does not have to be documented in this situation. Each subcontractor shall describe his laboratory custody procedures in his QA Plan; GCA will evaluate the internal custody procedures in use by each laboratory to ensure they are adequate for this program.

6.0 SAMPLING INTERNAL QC CHECKS

The sampling program includes the collection of air, water, soil, sediment and biota samples and onsite measurements of meteorological conditions. The hydrogeologic study includes geophysical survey measurements, and the collection of groundwater samples from monitoring wells. Samples of unconsolidated well core sediments will also be collected.

Appendix A to this QA Plan presents the sampling procedures to be followed for collecting each type of sample and incorporates information on appropriate sample collection equipment, types of sample containers and their cleanup, preservation required, field blanks and chain-of-custody procedures. Calibration procedures for air sampling and meteorological equipment are included.

The tables in this section summarize the internal QC measures to be used in sample collection, meteorological and geophysical survey measurements by the sampling and geotechnical subcontractors. Groundwater samples are included with other water samples in Table 6.3.1 and well core sediments are included in Table 6.4.1 on soil and sediment sampling.

TABLE 6.1.1. AIR SAMPLING INTERNAL QC CHECKS

Pollutants measured	Operation check	Control limits	Planned corrective action
Volatile Organics	1. DuPont P-125 Sampler		
Tenax collection	1a. Battery check at site, prior to startup	1a. Battery check LED should light	1a. Use backup pump
	1b. Low flow detector check (no load) at site prior to startup	1b. Low flow detector LED should not light	1b. Use backup pump
	1c. Low flow detector check (load imposed) at site prior to startup	1c. Low flow detector LED should light	1c. Use backup pump
	1d. Pump operation check at site, just after startup	1d. Pump should operate	1d. Use backup pump
	1e. Low flow detector check at site, just after startup	1e. Low flow detector LED should not light	1e. Use backup pump
	1f. Flow rate check[a] at site, just before end of sampling	1f. Low flow detector LED should not light	1f. Make notation on sampling sheet, sample tag, chain of custody form
	2. One Tenax field blank/ sampling team/sampling day	2. To be determined	2a. Correct for blank 2b. Check sampling and analytical procedures 2c. Invalidate results
	3. 11% of samples collected in duplicate	3. Not applicable	3. Not applicable

(continued)

TABLE 6.1.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Pesticides/Related Organics	1. DuPont P-4000 Sampler		
Polyurethane foam collection	1a. Battery check at site, prior to startup	1a. Battery check LED should light	1a. Use backup pump
	1b. Low flow detector check (no load) at site prior to startup	1b. Low flow detector LED should not light	1b. Use backup pump
	1c. Low flow detector check (load imposed) at site, prior to startup	1c. Low flow detector LED should not light	1c. Use backup pump
	1d. Pump operation check at site, just after startup	1d. Low flow detector LED should not light	1d. Use backup pump
	1e. Low flow detector check at site, just after startup	1e. Low flow detector LED should not light	1e. Use backup pump
	1f. Flow rate check[b] at site, just before end of sampling	1f. Low flow detector LED should not light	1f. Make notation on sampling sheet, sample tag, chain of custody form
	2. One foam plug field blank/sampling team/ sampling day	2. To be determined	2a. Correct for blank 2b. Check sampling and analytical procedures 2c. Invalidate results
	3. 15% of samples collected in duplicate	3. Not applicable	3. Not applicable

(continued)

TABLE 6.1.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Metals Hi-Vol collection	1a. Flow recorder zero at site, prior to startup	1a. Chart should be set at zero	1a. Adjust
	1b. Initial flow rate check, 5 minutes after startup	1b. Initial stabilized flow should be within ±10% of established initial flow	1b. Use backup system
	1c. Flow rate range at end of sampling	1c. Mean flow rate should be between 30-60 C.F.M.	1c. Make notations
	1d. Filter condition at end of sampling	1d. No evidence of leakage	1d. Make notations
	2. 18% samples collected in duplicate	2. Not applicable	2. Not applicable

[a]Geomet Technologies, Inc. (GTI) Procedure GTI/LC-A-OP-001.

[b]Procedure GTI/LC-A-OP-002.

TABLE 6.1.2. AIR SAMPLING EQUIPMENT CALIBRATION QC CHECKS

Equipment	Calibration check	Control limits	Planned corrective action
DuPont P-125 Air Sampler	1. DuPont flow rate calibration system and bubble tubes[a] before/after sampling day.	1a. Flow rate range 26-30 cc/min. 1b. Replicate bubble tube runs within ±5% of mean flow rate.	1a. Repair pump. 1b. Remove pump from service.
	2. Flow rate calibration as above using increased pressure drop simulating media loading before/after sampling day.	2. Flow rate with increased resistance must be within ±5% of mean flow rate.	2a. Repair pump. 2b. Remove pump from service.
DuPont P-4000 Air Sampler	1. Flow rate calibration with DuPont calibration system and bubble tubes.[b]	1a. Flow rate range 1270 ±5% cc/min. 1b. Replicate bubble tube runs must be within ±5% of mean flow rate.	1a. Repair pump. 1b. Remove pump from service.
	2. Flow rate calibration as above using increased pressure drop simulation media loading before/after sampling day.	2. Flow rate with increased resistance must be within ±5% of mean flow rate.	2a. Repair pump. 2b. Remove pump from service.

(continued)

TABLE 6.1.2 (continued)

Equipment		Calibration check		Control limits		Planned corrective action
High Volume Air Sampling System						
Sampler (Flow Recorder)	1a.	Flow rate calibration with orifice system[c] on receipt, after major maintenance and at study completion.	1a.	$Q_o - Q_c \leq 0.05\ Q_c$ Q_o=Observed flow rate Q_c=Calib. curve flow rate.	1a.	Rerun points for which the control limit is exceeded until acceptance is obtained.
Elapsed Time Meter	1b.	Accuracy check against Base reference chronometer[d] at start and completion of study	1b.	±2 min/24 hrs.	1b.	Adjust or replace meter.
On/Off Timer	1c.	Tripping accuracy check against elapsed time meter at start and completion of study.	1c.	±15 min/24 hrs.	1c.	Adjust or replace timer.
Base Reference Chronometer	1a.	Check synchronization against U.S. Naval Observatory Master Clock[e] daily.	1a.	±1 sec/ synchronization	1a.	Repeat synchronization to attain acceptability.
	1b.	Check accuracy against U.S. Naval Observatory Master Clock daily.	1b.	±1 sec/24 hr accuracy.	1b.	Adjust or replace

(continued)

TABLE 6.1.2 (continued)

Equipment	Calibration check	Control limits	Planned corrective action
Digital LCD Quartz Watches	1a. Synchronize against Base reference Chronometer[f] each sampling day.	1a. ±2 sec synchronization.	1a. Repeat to achieve synchronization.
	1b. Check accuracy against Base reference Chronometer at end of sampling.	1b. ±10 sec/12 hrs.	1b. Replace watch.
Stopwatches	1. Check time accuracy against Base reference Chronometer[g] at beginning and end of study or in case of accidental mishandling.	1. ±0.6 sec/10 min (0.1%).	1. Replace stopwatch.
Bubble Tubes and Burets	1. Check volume accuracy with water displacement[h] at beginning of study.	1. ±1% for 50 ml tubes.	1. Use empirical correction factor.

[a] Geomet Technologies, Inc. (GTI) Procedure GTI-LC-A-CP-008.

[b] Procedure GTI/LC-A-CP-009

[c] Procedure GTI/LC-A-CP-007.

[d] Procedure GTI/LC-A-CP-004.

[e] Procedure GTI/LC-A-CP-002.

[f] Procedure GTI/LC-A-CP-003.

[g] Procedure GTI/LC-A-CP-006.

[h] Procedure GTI/LC-A-CP-001.

TABLE 6.2.1. METEOROLOGICAL MONITORING INTERNAL QC CHECKS

Parameter(s) measured	Operation check	Control limits	Planned corrective action
Temperature-Outdoor (Hygrothermograph)	1. Check against aspirated psychrometer thermometer[a] weekly.	1. ±1.0°C (2°F)	1a. Adjustment and recalibration. 1b. Determine extent of data affected.
Relative Humidity-Outdoor (Hygrothermograph)	1. Check against relative humidity determined with sling psychrometer[a] weekly.	1. ±3% R.H.	1a. Recheck. 1b. If outside limit recalibrate.
Relative Humidity-Indoor (Aspirated Psychrometer)	1. Thermometers during each use. 2. Reservoir water level during each use. 3. Fan operation[b] during each use.	1. Visual inspection. 2. Visual inspection. 3. Visual inspection.	1. Replace if damaged. 2. Refill reservoir. 3. Replace batteries.
Wind Speed (Anemometer)	1. Readout to be checked for reasonability against visual observations of existing meteorological conditions daily.[c]	1. Reasonable correlation.	1a. Calibration check. 1b. Recalibrate.
Wind Direction (Wind sensor and recorder)	1. Readout to be checked for reasonability against visual observations of existing meteorological conditions daily.[c]	1. Reasonable correlation.	1. Calibration check if observations warrant action.
Precipitation (Tipping-bucket rain gauge)	1. Readout to be checked against existing meteorological conditions daily. 2. Visual check for gross response during or after rainfall.	1. Reasonable correlation. 2. Proper response judged visually.	1. Calibration check if observations warrant action. 2a. Free blocked bucket or repair poor gauge contact.[d] 2b. Determine extent of data affected.

[a] GTI Procedure GTI/LC-M-OP-004.

[b] GTI Procedure GTI/LC-M-OP-005.

[c] GTI Procedure GTI/LC-M-OP-002.

[d] GTI Procedure GTI/LC-M-OP-001.

TABLE 6.2.2. METEOROLOGICAL MONITORING EQUIPMENT CALIBRATION QC CHECKS

Equipment	Calibration check	Control limits	Planned corrective action
Hygrothermograph	1. Temperature checked at 2 points against reference thermometers[a] at start and completion of study.	1. ±1°C (±2°F).	1. Repeat calibration or replace unit if necessary.
	2. RH checked at 2 points against sling or aspirated psychrometer[b] at start and completion of study.	2. ±3%RH(20-80%RH).	2. Recalibrate or replace if necessary.
Aspirated Psychrometer	1. Temperature checked at 2 points against reference thermometers[c] monthly.	1. ±0.5°C	1. Replace thermometers.
Wind Speed/Direction Measurement System	1. Wind direction-Align true north against well-documented true north landmarks. Check 3 other directions on chart[d] at start and completion of study.	1. ±3° azimuth.	1a. Adjust transducer assembly. 1b. Replace unit.
Rain Gauge	1. Check digital accumulator with water equivalent to 1 inch precipitation[e] at start and completion of study.	1. ±0.02 inches accuracy.	1a. Make repairs or adjustments in the field. 1b. Replace gauge.

[a] Geomet Technologies, Inc. (GTI) Procedure GTI/LC-M-CP-005.

[b] Procedure GTI/LC-M-CP-004.

[c] Procedure GTI/LC-M-CP-006.

[d] Procedure GTI/LC-M-CP-002.

[e] Procedure GTI/LC-M-CP-001.

TABLE 6.3.1 WATER SAMPLING INTERNAL QC CHECKS

Pollutants measured	Operation check	Control limits	Planned corrective action
Volatile Organics	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. 5% of samples collected in triplicate.	2. Not applicable.	2. Not applicable.
Semivolatile Organics	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. 5% of samples collected in triplicate.	2. Not applicable.	2. Not applicable.
Pesticides	1. One reagent water field blank/sample type/ sampling team/sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. 5% of samples collected in triplicate.	2. Not applicable.	
Metals	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. 5% of samples collected in triplicate.	2. Not applicable.	2. Not applicable.
Fluorides/Nitrates	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. 5% of samples collected in triplicate.	2. Not applicable.	2. Not applicable.
Dioxins (TCDD)	1. One reagent Type 1 water field blank/ sampling team/sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. 5% of samples collected in triplicate.	2. Not applicable.	2. Not applicable.
Radioactivity	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. All samples collected in duplicate.	2. Not applicable.	2. Not applicable.
Total Organic Carbon (TOC)/ Total Organic Halogens (TOX)/ pH/Conductivity (Groundwater only)	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. 5% of samples collected in triplicate.	2. Not applicable.	2. Not applicable.

TABLE 6.4.1 SOIL AND SEDIMENT SAMPLING INTERNAL QC CHECKS

Pollutants measured	Operation check	Control limits	Planned corrective action
Volatile Organics	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. Collect 10% of samples in triplicate.	2. Not applicable.	2. Not applicable.
Semivolatile Organics	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. Collect 10% of samples in triplicate.	2. Not applicable.	2. Not applicable.
Pesticides	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. Collect 10% of samples in triplicate.	2. Not applicable.	2. Not applicable.
Inorganic (Metals)	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. Collect 10% of samples in triplicate.	2. Not applicable.	2. Not applicable.
Dioxins (TCDD)	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. Collect 10% of samples in triplicate.	2. Not applicable.	2. Not applicable.
Radioactivity	1. One reagent water field blank/sampling team/ sampling day.	1. No significant concentrations found.	1a. Correct for field blank. 1b. Check sampling and analytical procedures. 1c. Invalidate results.
	2. Collect 10% of samples in duplicate.	2. Not applicable.	2. Not applicable.

TABLE 6.5.1 BIOTA SAMPLING EQUIPMENT QC CHECKS

Equipment	Operation check	Control limits	Planned corrective action
VICTOR-Mouse and Rat Traps	1. Test tripping mechanism before setting.	1. Proper tripping of bait pedal.	1. Repair or replace.
HAVE-A-HEART Live Traps	1. Test tripping mechanism before setting.	1. Proper tripping of bait pedal.	1. Repair or replace.
Trap Line inspection	1. Survey of trap line for security hourly.	1. Trap line must not be disturbed.	1. Make notation on field data sheets, sample tag, chain-of-custody form.

TABLE 6.6.1 GEOPHYSICAL SURVEY EQUIPMENT QC CHECKS

Equipment	Operation check	Planned corrective action
Ground Penetrating Radar	1. Calibrate with 10 nano-second standard daily.	1. Not applicable.
	2. Reference to a feature at known depth at each site.	2. Correct data reports.
Electromagnetic Sensor	1. Check system linearity by recording zero and upper scale readings on each traverse.	1. Correct data reports.
Resistivity Sensor	1. Check with dummy load.	1. Correct data reports.
Magnetometer	1. Calibrate against magnet traceable to a primary standard.	1. Not applicable.
	2. Check for sensitivity at each site.	2. Correct data reports

7.0 ANALYTICAL INTERNAL QC CHECKS

Appendix B to this QA Plan presents the analytical procedures to be used for Love Canal Study samples classified according to the media sampled and the analysis performed. A section on quality control procedures fully incorporating all EPA QC requirements is provided for each analytical procedure.

This information has been provided to all analytical subcontractors as part of their subcontract document and, again, in the sections of Appendix B pertinent to their project analytical work. Each subcontractor's QA Plan has been evaluated to ensure that it incorporates EPA's required internal QC measures and identifies a project QA coordinator responsible for implementing these measures.

The tables in this section summarize the quality control procedures given in Appendix B; the reader interested in more detail should refer to that volume.

7.1 AIR MONITORING

Air samples will be collected on Tenax cartridges, foam plugs and Hi-Vol filters. Unexposed collection media will be provided to the appropriate analytical laboratory for use as method blanks. In addition, primary calibration standards and calibration check standards for analysis of Tenax cartridges and dioxin samples will be provided. All standards for foam plug analysis should be obtained through the Quality Assurance Section, HERL/RTP.

Instrument calibration specifications and calibration checks, appropriate internal standards, frequency of replicate analyses and method blanks are outlined in Table 7 1.1. The compounds to be spiked onto foam plugs to provide a Laboratory control standard (LCS) are identified and concentration levels given.

TABLE 7.1.1 ANALYTICAL INTERNAL QC CHECKS - AIR SAMPLES

Pollutants measured	Operation check	Control limits	Planned corrective action
Volatile Organics on Tenax	1. Tuning of mass spectrometer - Document 50 ng BFB and/or 50 ng DFTPP injected before analysis/ analysis day.	1a. DFTPP - Method 624, Table 3[a] 1b. BFB - as follows: Mass — Ion Abundance 50 — 15-40% of the base peak 75 — 30-60% of the base peak 95 — base peak, 100% relative abundance 96 — 5-9% of the base peak 173 — less than 1% of the base peak 174 — greater than 50% of the base peak 175 — 5-9% of mass 174 176 — greater than 50% of the base peak 176 — greater than 94% but less than 100% of 174 177 — 5-9% of mass 176	1. Retune spectrometer
	2. Verify capillary column performance - Inject before analysis/ analysis day the "Grob" mixture: Acetophenone 2,6-Dimethylphenol 2,6-Dimethylaniline Nonanone Ethyl benzene p-Xylene	2a. RESOLUTION = $\frac{2(W_1 - W_2)}{W_1 + W_2}$ <1.20 where W_1 = average base width of ethylbenzene measured at the base W_2 = average base width of p-xylene measured at the base 2b. PERCENT PEAK ASYMMETRY FACTOR (PAF) % PAF = $\frac{B}{F} \times 100$ where B = area of back half of peak F = area of front half of peak Both measured at 10 percent above baseline % PAF for acetophenone ≤ 260 % PAF for nonanone ≤ 130 These criteria (2b) do not apply to cases in which frontal tailing or frontal shoulders are apparent. These situations, where F is greater than B, are highly unlikely to occur and must be evaluated on an individual basis. 2c. ACIDITY TEST (A.T.) = 1 ± 0.1 A.T. = $\frac{PAWB}{PAA}$ where PAWB = peak area of dimethylaniline PAA = peak area of acetophenone 2d. BASICITY TEST (B.T.) = 0.8 ± 0.03 B.T. = $\frac{PAWA}{PAA}$ where PAWA = peak area of dimethylphenol PAA = peak area of acetophenone	2a. Check analytical procedure 2b. Rerun "Grob" mixture 2c. Replace capillary column
	3. Internal standard (optional) - Add hexafluorobenzene to every Tenax cartridge (blank, sample, standard)	3. Not applicable.	3. Not applicable.
	4. Thermal desorption system check - Verify proper operating temperatures and flow rates/8 hours of analysis.	4. To be determined	4a. Adjust to appropriate levels 4b. Verify analytical results obtained while flows and/or temperatures were incorrect.

(continued)

TABLE 7.1.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Volatile Organics on Tenax	5. Calibration check of GC/MS system - Analyze one standard Tenax cartridge, including the internal standard if applicable/8 hours of analysis (during first half of this 8 hour period).	5. Deviation less than ±20 percent of actual.	5a. Check analytical procedure. 5b. Analyze a second reference standard. 5c. Invalidate results and generate new standard curve.
	6. Method blank (blank Tenax cartridge) - Analyze one blank Tenax cartridge/8 hours of analysis and/or after sample(s) with heavy organic loading. Maintain log of sequence in which blanks are run.	6. No significant concentrations found.	6a. Check analytical procedure. 6b. Analyze reference sample. 6c. Invalidate results.
Pesticides and related Compounds on Polyurethane Foam Plugs	1. Calibration of instrument - Generate 3-point calibration curve of all compounds to be quantified before analysis of samples/analysis day.	1. Not applicable.	1. Not applicable.
	2. Calibration check of instrument - Analyze single concentration mixed standard of compounds to be quantified after every fifth samples.	2. Deviation less than ±6% from calibration curve for all compounds detected in samples.	2a. Generate fresh calibration curve. 2b. Re-analyze samples run since last acceptable standard check.
	3. Method blank (blank foam plug) - Extract and analyze one blank foam plug/analysis batch[b]/analysis day.	3. No significant concentrations found.	3a. Check analytical procedure. 3b. Correct for blank.
	4. Internal standard - Add 2,2'-Dichloro-p-xylene to every sample extract at a known concentration.	4. Not applicable.	4. Not applicable.
	5. Qualitative compound check - Analyze one mixed standard of all compounds for qualitative analysis after every tenth sample.	5. Verify retention times.	5a. Check analytical procedure. 5b. Analyze a second reference sample. 5c. Invalidate results.
	6. Laboratory control standard (LCS) - Analyze one LCS/analysis batch[b]/analysis day. LCS to be spiked foam plug containing 250-400 ng per whole plug of the following: Lindane Hexachlorobenzene Hexachlorocyclopentadiene 1,2,3,4-Tetrachlorobenzene 1,2,3-Trichlorobenzene 1,2,4-Trichlorobenzene 1,3,5-Trichlorobenzene 2,4,5-Trichlorophenol Pentachlorobenzene	6. To be determined - acceptable recovery levels for spiked polyurethane foam plugs have not yet been established and must be determined as the program progresses.	6a. Check analytical procedure. 6b. Analyze a second reference sample. 6c. Invalidate results.

(continued)

TABLE 7.1.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Pesticides and Related Compounds on Polyurethane Foam Plugs	7. Sensitivity check - Verify proper instrument sensitivity as part of calibration check.	7. Lindane (225 pg) gives 50 percent of full scale deflection.	7a. Adjust to appropriate levels. 7b. Recalibrate as necessary.
Metals on Hi-Vol Filters	1. Calibration and standardization - Generate calibration curve by analysis of 5 working standards of each element to be quantified. Average of two burns to form calibration curve. Required for each session of analysis (3-3½ hours).	1. Not applicable.	1. Not applicable.
	2. Calibration checks of instrument - a. Analyze the zero standard after every 20 samples. b. Analyze LOQC or HIQC after every 10 samples.	2a. No significant drift observed. 2b. Control limits for LOQC/HIQC are specified in computer control program.[c]	2a. Check analytical procedure. 2b. Analyze a second reference sample. 2c. Invalidate results and recalibration.
	3. Method blank (blank hi-vol filter) - a. Thirty (30) filters analyzed prior to start of program. b. Analyze one filter blank for every 20 samples.	3a. Establish mean levels and discrimination limits for each element to correct analytical results for filter contribution. 3b. No significant concentration found and levels meet criteria established in preliminary study.	3a. Check analytical procedure. 3b. Analyze reference sample. 3c. Analyze reagent blank. 3d. Invalidate results.
	4. Method blank (reagent water) - a. Analyze reagents for elements of interest prior to start of program. b. Optionally, analyze one reagent blank for every 50 samples.	4. No significant concentrations found.	4a. Check analytical procedure. 4b. Analyze reference sample. 4c. Invalidate results.
	5. Replicate analysis - Extract and and analyze a duplicate aliquot of one (1) of every 20 samples.	5. To be determined.	5a. Check analytical procedure. 5b. Analyze reference sample. 5c. Invalidate results.
Dioxin (2,3,7,8-TCDD)	1. Internal standard - Add to each sample a known amount of $^{37}Cl_4$-TCDD to determine percent recovery.	1. Not applicable.	1. Report percent recovered for each sample.
	2. Confirmation of 2,3,7,8-TCDD using LRGC/HRMS.	2a. Both TCDD peaks (m/z 320, m/z 322) must be present. 2b. TCDD peaks (m/z 320, m/z 322) must be greater than 2.5 times the noise level. 2c. TCDD peak intensities (m/z 320, m/z 322) must show correct chlorine isotope ratio (0.8:1.0). 2d. TCDD GC retention time must be correct.	2. Terminate analysis and report TCDD not detected.

(continued)

TABLE 7.1.1 (continued)

Pollutants measured	Operation check	Control Limits	Planned corrective action
Dioxin (2,3,7,8-TCDD)	3. Confirmation of 2,3,7,8-TCDD using capillary column GC/HRMS - If criteria of No. 2 above are met, sample extracts are reanalyzed by this technique.	3a. Correct capillary column GC/HRMS retention time for TCDD. 3b. Correct chlorine isotope ratio for the molecular ions (m/z 320, m/z 322). 3c. Correct capillary column GC/HRMS multiple ion monitoring responses for TCDD masses and ^{37}Cl-TCDD mass (simultaneous response for elemental composition of m/z 320, m/z 322, m/z 328). 3d. Correct responses for co-injection of sample fortified with ^{37}Cl-TCDD and TCDD standard. 3e. Response of m/z 320 and m/z 322 (TCDD) must be greater than 2.5 times the noise level.	3. Terminate analysis and report TCDD not detected.

[a]Method 624, Federal Register, Vol. 44, No. 233, December 3, 1979. pp. 69532-69539.

[b]Analysis batch = Group of samples processed as a set, usually containing 15 or fewer samples.

[c]Analysis for metals on hi-vols is performed by EMSL/RTP. Control limits have been established by that group and are automatically checked by the computer control program prior to analysis of the next sample.

7.2 WATER MONITORING

Several types of water - residential sumps, sewer and surface waters, drinking water supplies and ground waters - will be analyzed for the pollutants listed in Table 7.2.1. The compounds specified for use as internal standards or organic surrogate compounds will be provided to the subcontractor laboratories as stated in Appendix B.

Laboratory control standards (LCS) will be employed to control systematic method and operator errors. The LCS is a solution of one or more analytes of known concentration in reagent water; each will be prepared using either EMSL/Cincinnati quality control concentrates or standards supplied by the individual laboratory. The analytes which must be included, as a minimum, for each method are given in Table 7.2.1 along with the required concentration range. A control chart should be maintained for each of the analytes using the control limits given in Table 7.2.1.

The same table includes instrument calibration specifications and calibration checks, frequency of method blanks and replicate analyses; the metals, anions, and concentration ranges to be used to spike each type of water sample are given.

TABLE 7.2.1. ANALYTICAL INTERNAL QC CHECKS - WATER SAMPLES

Pollutants measured	Operation check	Control limits	Planned corrective action
Pesticides and Related Compounds on Polyurethane Foam Plugs	7. Sensitivity check - Verify proper instrument sensitivity as part of calibration check.	7. Lindane (225 pg) gives 50 percent of full scale deflection.	7a. Adjust to appropriate levels. 7b. Recalibrate as necessary.
Metals on Hi-Vol Filters	1. Calibration and standardization - Generate calibration curve by analysis of 5 working standards of each element to be quantified. Average of two burns to form calibration curve. Required for each session of analysis (3-3½ hours).	1. Not applicable.	1. Not applicable.
	2. Calibration checks of instrument - a. Analyze the zero standard after every 20 samples. b. Analyze LOQC or HIQC after every 10 samples.	2a. No significant drift observed. 2b. Control limits for LOQC/HIQC are specified in computer control program.[c]	2a. Check analytical procedure. 2b. Analyze a second reference sample. 2c. Invalidate results and recalibration.
	3. Method blank (blank hi-vol filter) - a. Thirty (30) filters analyzed prior to start of program. b. Analyze one filter blank for every 20 samples.	3a. Establish mean levels and discrimination limits for each element to correct analytical results for filter contribution. 3b. No significant concentration found and levels meet criteria established in preliminary study.	3a. Check analytical procedure. 3b. Analyze reference sample. 3c. Analyze reagent blank. 3d. Invalidate results.
	4. Method blank (reagent water) - a. Analyze reagents for elements of interest prior to start of program. b. Optionally, analyze one reagent blank for every 50 samples.	4. No significant concentrations found.	4a. Check analytical procedure. 4b. Analyze reference sample. 4c. Invalidate results.
	5. Replicate analysis - Extract and and analyze a duplicate aliquot of one (1) of every 20 samples.	5. To be determined.	5a. Check analytical procedure. 5b. Analyze reference sample. 5c. Invalidate results.
Dioxin (2,3,7,8-TCDD)	1. Internal standard - Add to each sample a known amount of $^{37}Cl_4$-TCDD to determine percent recovery.	1. Not applicable.	1. Report percent recovered for each sample.
	2. Confirmation of 2,3,7,8-TCDD using LRGC/HRMS.	2a. Both TCDD peaks (m/z 320, m/z 322) must be present. 2b. TCDD peaks (m/z 320, m/z 322) must be greater than 2.5 times the noise level. 2c. TCDD peak intensities (m/z 320, m/z 322) must show correct chlorine isotope ratio (0.8:1.0). 2d. TCDD GC retention time must be correct.	2. Terminate analysis and report TCDD not detected.

(continued)

TABLE 7.2.1. (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Volatile Organics	7. Replicate analysis - Analyze, using complete procedure, a second aliquot of one (1) of every ten (10) samples.	7. To be determined.	7a. Check analytical procedure 7b. Analyze reference sample. 7c. Invalidate results.
Acrolein, Acrylonitrile	1. Method blank (reagent water) - Analyze method blank before analysis batch[b]/analysis day.	1. No significant concentrations found.	1a. Check analytical procedure 1b. Correct for blank.
	2. Purging efficiency - Determine purging efficiency for each compound before analysis/analysis day.	2. Acrolein, 80-90% Acrylonitrile, 93-103%	2. Check analytical procedure.
	3. Laboratory control standard (LCS) - Analyze one LCS per analysis batch[b]/analysis day. LCS to contain 5-25 µg/l of each: Acrolein Acrylonitrile	3. ±2 standard deviations.	3c. Check analytical procedure. 3b. Analyze second reference sample. 3c. Invalidate results.
Semivolatile Organics	1. Tuning of mass spectrometer - Document injection of 50 ng DFTPP before analysis/analysis day.	1. Method 625, Table 10[d]	1. Retune spectrometer.
	2. Verify a capillary column performance - a. Inject simultaneously, using 1 µl injection size, 100 ng Pentachlorophenol and benzidine. b. Analysis of the "Grob" mixture: Acetophenone 2,6-Dimethylphenol 2,6-Dimethylaniline Nonanone Ethyl Benzene p-Xylene	2. Tailing factor for those compounds ≤1.5.	2a. Check analytical procedure. 2b. Analyze reference sample. 2c. Replace capillary column.
	3. Method blank (reagent water) - Analyze one method blank/analysis batch[b]/analysis day.	3. No significant concentrations found.	3a. Check analytical procedure 3b. Correct for blank.
	4. Calibration check of GC/MS system - Analyze single concentration mixed standard containing the internal standards/8 hours of analysis.	4. Deviation less than ±20 percent from actual.	4. Recalibrate system.

(continued)

TABLE 7.2.1. (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Semivolatile Organics	5. Surrogate compounds - Add the following compounds to every sample at a concentration of 5-25 µg/l:	5. Calculated as percent of true value:	5a. Check analytical procedure. 5b. Analyze reference sample. 5c. Invalidate results.
	2-Fluorophenol	18-58	
	1-Fluoronaphthalene	33-88	
	4,4'-Dibromooctafluorobiphenyl	34-98	
	6. Internal standards - Add the following compounds to each environmental sample at a known concentration:	6. Method 625, Section 6.4[d]	6a. Check analytical procedures. 6b. Analyze reference sample. 6c. Invalidate results.
	Naphthalene d_8		
	Anthracene d_{10}		
	Chrysene d_{12}		
	7. Laboratory control standards (LCS) - Analyze one (1) LCS/analysis batch[b]/analysis day. LCS to contain 5-25 µg/l of the following compounds:	7. Calculated as percent of true value:	7a. Check analytical procedure. 7b. Analyze second reference sample. 7c. Invalidate results.
	1,4-dichlorobenzene	16-64	
	1,2,4-trichlorobenzene	36-96	
	1,2,3,4-tetrachlorobenzene	35-59	
	Fluoranthene	40-118	
	2,4,6-trichlorophenol	46-82	
	2-chloronaphthalene	34-98	
	2,6-dinitrotoluene	34-94	
	4-nitrophenol	36-68	
	2-fluorophenol	18-58	
	Pentachlorophenol	63-111	
	Beta-benzenehexachloride	19-119	
	1-fluoronaphthalene	33-81	
	4,4-dibromobiphenyl	36-94	
	4,4-dibromooctafluorobiphenyl	34-98	
	Di-n-butylphthalate	45-125	
	8. Replicate analysis - Analyze, using complete procedure, a second aliquot of one (1) of every ten (10) samples.	8. To be determined.	8a. Check analytical procedure. 8b. Analyze reference sample. 8c. Invalidate results.
Benzidine	1. Method blank (reagent water) - Analyze one (1) method blank before analysis/analysis day.	1. No significant concentrations found.	1a. Check analytical procedure. 1b. Correct for blank.
	2. Laboratory control standard (LSC) - Analyze one (1) LCS/analysis batch[b]/analysis day. LCS to contain 5-25 µg/l of benzidine.	2. ±2 standard deviations.	2a. Check analytical procedure. 2b. Analyze second reference sample. 2c. Invalidate results.

(continued)

TABLE 7.2.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Hexachlorocyclopentadiene	1. Document injection port temperature.	1. Not applicable.	1. Not applicable.
	2. Method blank (reagent water) - Analyze one (1) method blank/analysis batch[b]/analysis day.	2. No significant concentrations found.	2a. Check analytical procedure. 2b. Correct for blank.
	3. Laboratory control standard (LCS) - Analyze one (1) LCS/analysis batch[b]/analysis day. LCS to contain 5-25 µg/l hexachorocyclopentadiene.	3. ±2 standard deviations.	3a. Check analytical procedure. 3b. Analyze second reference sample. 3c. Invalidate results.
Pesticides	1. Calibration and standardization - Perform as required by Method 608, Section 7[e].	1. Method 608, Section 7[e].	1. Recalibrate and restandardize instrument.
	2. Method blank (reagent water) - Analyze one (1) reagent blank/analysis batch[b]/analysis day.	2. No significant concentrations found.	2a. Check analytical procedure. 2b. Correct for blank.
	3. Laboratory control standard (LCS) - Analyze one (1) LCS/analysis batch[b]/analysis day. LCS to contain (at a minimum) 5-25 µg/l Aroclor 1242.	3. ±2 standard deviations.	3a. Check analytical procedure. 3b. Analyze second reference sample. 3c. Invalidate results.
	4. Replicate analysis - Analyze, using the complete procedure, a second aliquot of one (1) of every ten (10) samples.	4. To be determined.	4a. Check analytical procedure. 4b. Analyze reference sample. 4c. Invalidate results.
	5. Confirmation by GC/MS - Confirm identified pesticides using GC/MS analysis.	5. Identification confirmed.	5a. Analyze replicate aliquot by Method 608. 5b. Invalidate original Method 608 result.
Metals	1. Calibration and standardization - Calibrate and standardize instrument as required in analytical procedures.[f]	1. Standard analytical methods.[f]	1. Recalibrate and restandardize instrument.
	2. Method blank (reagent water) - Analyze one (1) method blank/analysis batch[b]/analysis day.	2. No significant concentrations found.	2a. Check analytical procedure. 2b. Correct for blank.

(continued)

TABLE 7.2.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Metals	3. Sample spiking (Initial study) - Add compounds of actual elements of interest to portions of the first ten (10) samples of each type of water. Spiked levels, as follows: Antimony 0.25 mg/l Arsenic 0.05 mg/l Barium 1.0 mg/l Beryllium 0.015 mg/l Cadmium 0.01 mg/l Chromium 0.05 mg/l Lead 0.05 mg/l Mercury 0.002 mg/l Nickel 0.15 mg/l Selenium 0.01 mg/l Thallium 1.0 mg/l Zinc 5.0 mg/l (Spiked levels given prior to concentration.)	3. 85-115% recovery of added element.	3. Use method of standard additions to quantitate samples of that water type.
	4. Sample spiking (check) - If control limits of No. 3 above are met, spike one (1) of the next twenty (20) of each type of sample with the concentrations specified above.	4. 85-115% recovery of added element.	4. Use method of standard additions to quantitate samples of that water type.
	5. Laboratory control standard (LCS) - Analyze one (1) LCS/analysis batch[b]/analysis day. LCS to contain the following elements, as appropriate, at concentrations specified:	5. Calculated as percent of true value:	5a. Check analytical procedure. 5b. Analyze second reference sample. 5c. Invalidate results.
	Antimony ≃0.5 mg/l	90-110	
	Arsenic ≃0.3 mg/l	89-111	
	Barium ≃1.0 mg/l	95-105	
	Beryllium ≃0.5 mg/l	95-105	
	Cadmium ≃0.07 mg/l	95-105	
	Chromium ≃0.25	95-105	
	Lead ≃0.4 mg/l	92-108	
	Mercury 1-5 µg/l	65-110	
	Nickel ≃0.3 mg/l	96-104	
	Selenium 5-20 µg/l	92-108	
	Silver ≃0.05 mg/l	92-108	
	Thallium ≃0.05 mg/l	90-110	
	Zinc ≃0.4 mg/l	96-104	

(continued)

TABLE 7.2.1. (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Metals	6. Replicate analysis - Analyze, using the complete procedure, a second aliquot of one (1) of every ten (10) samples.	6. To be determined.	6a. Check analytical procedure. 6b. Analyze reference sample. 6c. Invalidate results.
Fluoride, Nitrate	1. Calibrate and standardize as prescribed in the appropriate analytical methods.[f]	1. Not applicable.	1. Not applicable.
	2. Method blank (reagent water) - Analyze one (1) method blank/analysis batch[b]/analysis day.	2. No significant concentrations found.	2a. Check analytical procedures. 2b. Correct for blank.
	3. Sample spiking (initial study) - Add compounds of the anions of interest to portions of the first ten (10) samples of each type of water. Spike levels, as follows: Fluoride 1.0 mg/l Nitrate 10.0 mg/l	3. 85-115% recovery of added anion.	3. Use method of standard additions to quantitate samples of that type water.
	4. Sample spiking (check) - If control limits of No. 3 above are met, spike one (1) of the next twenty (20) of each type water with the concentrations as specified above.	4. 85-115% recovery of added anion.	4. Use method of standard additions to quantitate samples of that type water.
	5. Laboratory control standard - (LCS) - Analyze one (1) LCS/analysis batch /analysis day. LCS to contain, as appropriate, the following: Fluoride 0.5-1.5 mg/l Nitrate 2-10 mg/l	5. Calculated as percent of true value: 92-108 92-108	5a. Check analytical procedure. 5b. Analyze second reference sample. 5c. Invalidate results.
	6. Replicate analysis - Analyze, using the complete procedure, a second aliquot of one (1) of every ten (10) samples.	6. To be determined.	6a. Check analytical procedure. 6b. Analyze reference sample. 6c. Invalidate results.
Total Organic Carbon (TOC)	1. Calibrate and standardize as required by Method 415.1[f]	1. Not applicable.	1. Not applicable.
	2. Method blank (reagent water) - Analyze one (1) method blank/analysis batch[b]/analysis day.	2. No significant concentrations found.	2a. Check analytical procedure.

(continued)

TABLE 7.2.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Total Organic Carbon (TOC)	3. Replicate analysis - Analyze, using the complete procedure, a second aliquot of one (1) of every ten (10) samples.	3. To be determined.	3a. Check analytical procedure. 3b. Analyze reference sample. 3c. Invalidate results.
Total Organic Halogens (TOX)	1. Calibrate and standardize as required by Dohrmann DX-20 instructions.	1. Not applicable.	1. Not applicable.
	2. Method blank (reagent water) - Analyze one (1) method blank/ analysis batch[b]/analysis day.	2. No significant concentrations found.	2a. Check analytical procedure. 2b. Correct for blank.
	3. Replicate analysis - Analyze, using the complete procedure, a second aliquot of one (1) of every ten (10) samples.	3. To be determined.	3a. Check analytical procedure. 3b. Analyze reference sample. 3c. Invalidate results.
pH	1. Calibrate and standardize as required by Method 150.1[f] using two (2) or more standard buffer solutions.	1. Not applicable.	1. Not applicable.
	2. Calibration check - Analyze a standard buffer solution after every ten (10) samples.	2. Deviation less than ±0.1 pH units.	2. Recalibrate instrument.
	3. Replicate analysis - Analyze, using the complete procedure a second aliquot of one (1) of of every ten (10) samples.	3. To be determined.	3a. Check analytical procedure. 3b. Analyze reference sample. 3c. Invalidate results.
Conductivity[g]	1. Standardize and calibrate daily before analysis using KCl solutions.	1. Not applicable.	1. Not applicable.
	2. Calibration check - Analyze a standard KCl solution after every ten (10) samples.	2. Derivation less than ±1 percent or less than ±1 umho/cm, whichever is greater.	2a. Recalibrate instrument. 2b. Reanalyze all samples run since last acceptable calibration check.
	3. Replicate analysis - Analyze, using full procedure, a second aliquot of one (1) of every ten (10) samples.	3. To be determined.	3a. Check analytical procedure. 3b. Analyze reference sample. 3c. Invalidate results.

(continued)

TABLE 7.2.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Dioxin (2,3,7,8-TCDD)	1. Internal standard - Add to each sample a known amount of $^{37}Cl_4$-TCDD to determine percent recovery for each sample.	1. Not applicable.	1. Report percent recovered for each sample.
	2. Confirmation of 2,3,7,8-TCDD using LRGC/HRMS.	2a. Both TCDD peaks (m/z 320, m/z 322) must be present. 2b. TCDD peaks (m/z 320, m/z 322) must be greater than 2.5 times the noise level. 2c. TCDD peak intensities (m/z 320, m/z 322) must show correct chlorine isotope ratio (0.8:1.0). 2d. TCDD GC retention time must be correct.	2. Terminate analysis and report TCDD not detected.
	3. Confirmation of 2,3,7,8-TCDD using capillary column GC/HRMS. If criteria of No. 2 above are met, sample extracts are reanalyzed by this technique.	3a. Correct capillary column GC/HRMS retention time for TCDD. 3b. Correct chlorine isotope ratio for the molecular ions (m/z 320, m/z 322). 3c. Correct capillary column GC/HRMS multiple ion monitoring responses for TCDD masses and ^{37}Cl-TCDD mass (simultaneous responses for elemental composition of m/z 320, m/z 322, m/z 328). 3d. Correct responses for co-injection of sample fortified with ^{37}Cl-TCDD and TCDD standard. 3e. Response of m/z 320 and m/z 322 (TCDD) must be greater than 2.5 times the noise level.	3. Terminate analysis and report TCDD not detected.
Radioactivity	QC procedures for radioactivity measurements will be provided by EMSL, Las Vegas.		

[a] Method 624, Federal Register, Vol. 44, No. 233, December 3, 1979, pp. 69532-69539.

[b] Analysis batch = group of samples processed as a set, usually containing 15 or fewer samples.

[c] May be present in Love Canal samples.

[d] Method 625, Federal Register, Vol. 44, No. 233, December 3, 1979, pp. 69540-69552.

[e] Method 608, Federal Register, Vol. 44, No. 233, December 3, 1979, pp. 69501-69509.

[f] Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020.

[g] Method 205, Standard Methods for the Examination of Water and Wastes, 14th edition, American Public Health Assoc., 1975.

7.3 SOIL AND SEDIMENT SAMPLE ANALYSIS

Soils from home sites and other wet and dry areas and sediments from sumps, sewers, rivers and streams will be collected for analysis. Unconsolidated sediment well core samples will also be collected; Table 7.3.1 gives the pollutant classes measured in the samples. The compounds specified for use as internal standards, organic spiking and surrogate compounds will be provided to the analytical subcontractors.

The Laboratory control standard (LCS) used for soil and sediment samples is an NBS river sediment which is spiked with specified organic compounds for different types of analyses. Instrument calibration specifications and calibration checks, frequency of method blanks and replicate analyses and the metals to be spiked into samples are outlined in Table 7.3.1.

TABLE 7.3.1. ANALYTICAL INTERNAL QC CHECKS - SOIL AND SEDIMENT SAMPLES

Pollutants measured	Operation check	Control limits	Planned corrective action
Volatile Organics	1. Tuning of mass spectrometer - Document 50 ng BFB and/or 50 ng DFTPP injected before analysis/analysis day.	1a. DFTPP - Method 624, Table 3[a] 1b. BFB - as follows: Mass — Ion Abundance 50 — 15-40% of the base peak 75 — 30-60% of the base peak 95 — base peak, 100% relative abundance 96 — 5-9% of the base peak 173 — less than 1% of the base peak 174 — greater than 50% of the base peak 175 — 5-9% of mass 174 176 — greater than 50% of the base peak 176 — greater than 94% but less than 100% of 174 177 — 5-9% of mass 176	1. Retune spectrometer.
	2. Calibration check of GC/MS system - Analyze single concentration mixed standard containing internal standards/analysis shift (8 hours).	2. Deviation less than ±20 percent from actual.	2. Recalibrate system.
	3. Method blank (reagent water) - Analyze method blank before analysis batch[b]/analysis day.	3. No significant concentrations found.	3a. Check analytical procedure. 3b. Correct for blank.
	4. Surrogate compounds - Add the following compounds to every sample at a concentration of 100 ppb: Carbon tetrachloride $^{13}C_1$ 1,2-Dichloroethane d_4 p-Chlorotoluene d_4	4. ±2 standard deviations.	4a. Check analytical procedure. 4b. Analyze reference sample. 4c. Invalidate results.
	5. Internal standards - add the following compounds to every sample at known concentration: Dichloromethane d_2 Toluene d_8 Benzene d_6	5. Method 624, Sections 5.6 and 6.4[a]	5a. Check analytical procedure. 5b. Analyze reference sample. 5c. Invalidate results.
	6. Laboratory control standard (LCS) - Analyze one (1) LCS for every twenty (20) soil or sediment samples. LCS consists of 1 gram NBS-1645 sediment spiked with Purgeables B Mixture to give 100 ppb of the following: Chlorobenzene Toluene Benzene	6. Calculate as percent recovery.	6a. Check analytical procedure. 6b. Analyze second reference sample. 6c. Invalidate results.

(continued)

TABLE 7.3.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Volatile Organics	7. Replicate analysis - analyze, using complete procedure, a second aliquot of one (1) of every ten (10) samples.	7. To be determined.	7a. Check analytical procedure. 7b. Analyze reference sample. 7c. Invalidate results.
Semivolatile Organics	1. Tuning of mass spectrometer - Document injection of 50 ng DFTPP before analysis/analysis day.	1. Method 625, Table 10[c]	1. Retune spectrometer.
	2. Verify capillary column performance - a. Inject simultaneously, using 1 µl injection size, 100 ng pentachlorophenol and benzidine. b. Analysis of the "Grob" mixture: Acetophenone 2,6-Dimethylphenol 2,6-Dimethylaniline Nonanone Ethyl Benzene p-Xylene	2. Tailing factor for those compounds ≤1.5.	2a. Check analytical procedure. 2b. Analyze reference sample. 2c. Invalidate results.
	3. Method blank (reagent water) - Analyze one (1) method blank/analysis batch[b]/analysis day.	3. No significant concentrations found.	3a. Check analytical procedure. 3b. Correct for blank.
	4. Calibration check of GC/MS system - Analyze single concentration mixed standard containing the internal standards/8 hours of analysis.	4. Deviations less than ±20 percent from actual.	4. Recalibrate system.
	5. Surrogate compounds - Add the following compounds to every sample at a concentration of 250 µg/50 g sample: Hexachlorobenzene $^{13}C_6$ Pentachlorophenol $^{13}C_6$ 2-Chlorophenol $^{13}C_6$ Tetrachlorobenzene $^{13}C_6$ p-Chlorotoluene d_4	5. ±2 standard deviations.	5a. Check analytical procedure. 5b. Analyze reference sample. 5c. Invalidate results.
	6. Internal standards - Add the following compounds to every environmental sample at a known concentration: Naphthalene d_8 Anthracene d_{10} Chrysene d_{12}	6. Method 625, Section 6.4[c]	6a. Check analytical procedure. 6b. Analyze second reference sample. 6c. Invalidate results.

(continued)

TABLE 7.3.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Semivolatile Organics	7. Laboratory Control standard (LCS) - Analyze one (1) LCS for every twenty (20) soil or sediment samples. LCS to consist of 5 grams NBS 1645 sediment spiked to contain 5-10 ppm of the following: Base Neutrals: 1,2,4-Trichlorobenzene; 2,4-Dinitrotoluene; Di-n-butyl phthalate; Pyrene; N-nitroso-di-n-propylamine; 1,4-Dichlorobenzene Acids: Pentachlorophenol; 2-Chlorophenol; P-Chloro-m-cresol; 4-Nitrophenol	7. Calculate as percent recovery.	7a. Check analytical procedure. 7b. Analyze second reference sample. 7c. Invalidate results.
	8. Replicate analysis - Analyze, using complete procedures, a second aliquot of one (1) of every ten (10) samples.	8. To be determined.	8a. Check analytical procedure. 8b. Analyze reference sample. 8c. Invalidate results.
Pesticides	1. Calibration and standardization - Perform as required by Method 608, Section 7[d].	1. Method 608, Section 7[d]	1. Recalibrate and restandardize instrument.
	2. Method blank (reagent water) - Analyze one (1) reagent blank/analysis batch[b]/analysis day.	2. No significant concentrations found.	2a. Check analytical procedure. 2b. Correct for blank.
	3. Laboratory control standard (LCS) - Analyze one (1) LCS for every twenty (20) soil or sediment samples. LCS to consist of 5 grams NBS 1645 sediment spiked to contain 5-10 ppm of the following: Heptachlor; Aldrin; Dieldrin	3. Calculate as percent recovery.	3a. Check analytical procedure. 3b. Analyze second reference. sample. 3c. Invalidate results.
	4. Replicate analysis - Analyze, using complete procedure, a second aliquot of one (1) of every ten (10) samples.	4. To be determined.	4a. Check analytical procedure. 4b. Analyze reference sample. 4c. Invalidate results.
	5. Confirm identified pesticides using Method 625.	5. Identification confirmed.	5a. Analyze replicate aliquot by Method 608. 5b. Invalidate original Method 608 redults.

(continued)

TABLE 7.3.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Metals	1. Calibration and standardization - Calibrate and standardize instrument as required in analtyical procedures.[e]	1. Standard analytical methods.[e]	1. Recalibrate and restandardize instrument.
	2. Sample spiking - Add compounds of actual elements of interest to portions of first ten (10) samples of each type (soil, sediment). Spike level is to be two (2) times the endogenous level or ten (10) times the detection limit.	2. Recovery 85-115% for each element.	2. Analyze by Method of standard additions[e].
	3. Method blank (reagent water) - Analyze one (1) reagent blank/analysis batch[d]/analysis day.	3. No significant concentrations found.	3a. Check analytical procedure. 3b. Correct for blank.
	4. Laboratory control standard (LCS) - Analyze one (1) LCS for every twenty (20) soil or sediment samples. LCS to consist of 5 grams NBS 1645 sediment with values below as initial mean for control charts: Antimony (51) mg/kg Arsenic (66) mg/kg Cadmium 10.2 mg/kg Chromium 2.96 WT % Copper 109 mg/kg Lead 714 mg/kg Mercury 1.1 mg/kg Nickel 45.8 mg/kg Thallium 1.44 mg/kg Zinc 1720 mg/kg	4. Maintain control chart for each element. Develop 99 and 95 percent confidence levels (control and warning limits) through repetitive analyses.	4a. Check analytical procedure 4b. Analyze second reference sample. 4c. Invalidate results.
	5. Replicate analysis - Analyze, using complete procedure, a second aliquot of one (1) of every ten (10) samples.	5. To be determined.	5a. Check analytical procedure. 5b. Analyze reference sample. 5c. Invalidate results.
Dioxin (2,3,7,8-TCDD)	1. Internal standard - Add to each sample a known amount of $^{37}Cl_4$-TCDD to determine percent recovery for each sample.	1. Not applicable.	1. Report percent recovered for each sample.

(continued)

TABLE 7.3.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Dioxin (2,3,7,8-TCDD)	2. Confirmation of 2,3,7,8-TCDD using LRGC/HRMS. [a]	2a. Both TCDD peaks (m/z 320, m/z, 322) must be present. 2b. TCDD peaks (m/z 320, m/z 322) must be greater than 2.5 times the noise level. 2c. TCDD peak intensities (m/z 320, m/z 322) must show correct chlorine isotope ratio (0.8:1.0). 2d. TCDD GC retention time must be correct.	2. Terminate analysis and report TCDD not detected.
	3. Confirmation of 2,3,7,8-TCDD using capillary column GC/HRMS. If criteria of No. 2 above are met, sample extracts are reanalyzed by this technique.	3a. Correct capillary column GC/HRMS retention time for TCDD 3b. Correct chlorine isotope ratio for the molecular ions (m/z 320, m/z 322). 3c. Correct capillary column GC/HRMS multiple ion monitoring responses for TCDD masses and ^{37}Cl-TCDD (simultaneous response for elemental composition of m/z 320, m/z 322, m/z 328). 3d. Correct responses for co-injection of sample fortified with ^{37}Cl-TCDD and TCDD standard. 3e. Response of m/z 320 and m/z 322 (TCDD) must be greater than 2.5 times the noise level.	3. Terminate analysis and report TCDD not detected.
Radiactivity	Internal QC checks for radioactivity measurements will be provided by EMSL, Las Vegas.		

[a] Method 624, Federal Register, Vol. 44, No. 233, December 3, 1979, pp. 69532-69539.

[b] Analysis batch = group of samples processed as a set, usually containing 15 or fewer samples.

[c] Method 625, Federal Register, Vol. 44, No. 233, December 3, 1979, pp. 69540-69552.

[d] Method 608, Federal Register, Vol. 44, No. 233, December 3, 1979, pp. 69501-69509.

[e] Methods for Chemical Analysis of Water and Wastes, EPA-600-4-79-020. Atomic Absorption Spectroscopy procedures for metals.

7.4 BIOMONITORING PROGRAM

Mice, crayfish and earthworms will be collected for organic tissue analysis; potatoes and oatmeal will also be analyzed for organic compounds. Hair samples from mice and pet dogs and green leaf vegetation will be analyzed for metals. The specified surrogates, internal standards and Laboratory control standard (LCS) materials will be provided to the subcontractors.

Different types of LCS are used as appropriate. They include: reagent water spiked with specified organic compounds, an NBS Trace Elements in Water standard, reagent water spiked with metals and an NBS Orchard Leaves SRM containing metals. Instrument calibration specifications and calibration checks and the frequency of method blanks and replicate analyses are outlined in Table 7.4.1.

TABLE 7.4.1 ANALYTICAL INTERNAL QC CHECKS - BIOTA SAMPLES

Pollutants measured	Operation check	Control limits	Planned corrective action
Semivolatiles and Pesticides in Animal Tissue	1. Tuning of mass spectrometer - Document injection of 50 ng DTFPP before analysis/analysis day.	1. Method 625, Table 10[a]	1. Retune spectrometer.
	2. Calibration check of GC/MS system - Analyze one (1) single concentration mixed standard/8 hours of analysis.	2. Deviation less than 20 percent from actual.	2. Recalibrate instrument.
	3. Reagent blank - Analyze all reagent lots to be used prior to initiation of program.	3. No significant concentrations found.	3. Redistill solvents, recovering only 80 percent.
	4. Method blank (reagent water) - Analyze one (1) reagent blank/analysis batch[b]/analysis day.	4. No significant concentrations found.	4a. Check analytical procedure. 4b. Correct for blank.
	5. Repeated extraction - Re-extract every fifth sample to monitor initial extraction efficiency.	5. To be determined.	5. To be determined.
	6. Replicate analysis (depends on nature of sample) - Analyze, using complete procedure, a second aliquot of one (1) of every ten (10) samples.	6. To be determined.	6a. Check analytical procedure. 6b. Analyze reference sample. 6c. Invalidate results.
Volatile Organics in Foodstuffs	1. Calibration and Standardization - Calibrate GC using standards of compounds of interest at three (3) concentrations prior to analysis/analysis day.	1. Not applicable	1. Not applicable
	2. Calibration check - Inject single concentration calibration standard of all compounds/8 hours of analysis.	2. Deviation less than ±20 percent from actual.	2a. Check analytical procedure. 2b. Analyze second reference sample. 2c. Invalidate results.
	3. Method blank (reagent water) - Analyze one (1) method blank prior to analysis/analysis day.	3. No significant concentrations found.	3a. Check analytical procedure. 3b. Correct for blank.
	4. Surrogate compounds - Add to every sample at 5-25 µg/l the following compounds: Fluorobenzene p-Bromofluorobenzene	4. Calculated as percent of true value. 81-107 88-118	4a. Check analytical procedure. 4b. Analyze reference sample. 4c. Invalidate results.

(continued)

TABLE 7.4.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Volatile Organics in Foodstuffs	5. Laboratory control standard (LCS) - Analyze one (1) LCS/analysis batch[b]/analysis day. LCS to contain 5-25 ug/l of the following compounds:	5. Calculated as percent of true value:	5a. Check analytical procedure. 5b. Analyze second reference sample. 5c. Invalidate results.
	Benzene	79-107	
	Chloroform	90-100	
	Bromoform	76-107	
	sym-Tetrachloroethane	67-110	
	p-Bromofluorobenzene	88-118	
	Carbon tetrachloride	85-102	
	Fluorobenzene	81-107	
	Trichloroethylene	93-105	
	Tetrachloroethylene	93-120	
	Chlorobenzene	69-107	
	6. Replicate analysis - Analyze using complete procedure, a second aliquot of one (1) of every ten (10) samples.	6. To be determined.	6a. Check analytical procedure. 6b. Analyze reference sample. 6c. Invalidate results.
Trace Elements in Hair	1. Calibration and Standardization - Calibrate instrument(s) according to the procedures outlined in the standard analytical methods.[c]	1. Not applicable	1. Not applicable
	2. Method blank (reagent water) - Analyze with the samples one (1) method blank for approximately every twenty (20) hair samples to achieve, at a minimum, three (3) blanks for dog hair samples plus two (2) blanks for mouse hair samples.	2. No significant concentrations found.	2a. Check analytical procedure. 2b. Correct for blank.
	3. Laboratory control standard (LCS) - Analyze with the samples one (1) LCS of each type for approximately every twenty (20) hair samples to achieve, at a minimum, two (2) LCSs of each type for dog hair samples plus two (2) LCSs of each type for mouse hair samples.	3. ±2 standard deviations.	3a. Check analytical procedure. 3b. Analyze second reference sample. 3c. Invalidate results.
	a. One LCS to be used is the NBS SRM 1643a, trace elements in water, with content in ng/g as follows:		
	Arsenic 76 ± 7		
	Barium 46 ± 2		

(continued)

TABLE 7.4.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Trace Elements in Hair	Beryllium 19 ± 2 Cadmium 10 ± 1 Chromium 17 ± 2 Copper 18 ± 2 Lead 27 ± 2 Mercury* (<0.2) Nickel 55 ± 3 Selenium 11 ± 1 Silver 2.8 ± 0.3 Zinc 72 ± 4 *Mercury is not certified. b. The second LCS consists of laboratory water spiked with the elements of interest at a concentration approximately 4 to 5 times the analytical detection limit or about at the level of SRM 1643a.		
	4. Replicate analysis (if sufficient amounts of sample are available) - Analyze, using complete procedures a second aliquot of one (1) of every ten (10) samples.	4. Tc be determined.	4a. Check analytical procedure. 4b. Analyze reference sample. 4c. Invalidate results.
Trace Elements in Vegetation	1. Calibration and standardization - Calibrate instrument(s) according to the procedures outlined in the standard analytical methods.[c,d,e]	1. Not applicable	1. Not applicable
	2. Method blank (reagent water) - Analyze with the samples one (1) method blank for approximately every twenty (20) vegetation samples to achieve, at a minimum, two (2) blanks for the total number of vegetation samples.	2. No significant concentrations found.	2a. Check analytical procedure. 2b. Correct for blank.
	3. Laboratory control standard (LCS) - Analyze with the samples one (1) of each type LCS for approximately every twenty (20) vegetation samples to achieve, at a minimum, two (2) of each type LCS for the total number of vegetation samples. a. One LCS to be used is the NBS SRM 1571, Orchard Leaves, with content in µg/g as follows: Arsenic 10 Antimony 2.9	3. ±2 standard deviations.	3a. Check analytical procedure. 3b. Analyze second reference sample. 3c. Invalidate results.

(continued)

TABLE 7.4.1 (continued)

Pollutants measured	Operation check	Control limits	Planned corrective action
Trace Elements in Vegetation	Barium* 44 Beryllium 0.027 Cadmium 0.11 Chromium 2.6 Lead 45 Mercury 0.155 Nickel 1.3 Selenium 0.08 Zinc 25 *Barium is not certified. b. The second type of LCS consists of laboratory water spiked with the trace elements of interest at a concentration approximately 4-5 times the analytical detection limit or about the level of SRM 1571.		
	4. Replicate analysis (if sufficient amounts of sample are available) - Analyze, using complete procedures, a second aliquot of one (1) of every ten (10) samples.	4. To be determined.	4a. Check analytical procedure. 4b. Analyze reference sample. 4c. Invalidate results.

[a] Method 625, Federal Register, Vol. 44, No. 233, December 3, 1979, pp. 69540-69552.

[b] Analysis batch = group of samples processed as a set, usually containing 15 or fewer samples.

[c] Methods for Chemical Analysis of Water and Wastes EPA-600/4-79-020.

[d] ICP Method, Federal Register, Vol. 44, No. 233, December 3, 1979, pp. 69559-69564.

[e] Munns, R. K. and D. C. Holland, Rapid Digestion and Flameless Atomic Absorption Spectroscopy of Mercury in Fish: Collaborative Study, J. Assoc. Off. Anal. Chem. 60, 833, 1977.

8.0 PRECISION AND ACCURACY

8.1 GENERAL INFORMATION

This section integrates the prevision and accuracy measures planned by the different EPA laboratories involved in this study.

8.1.1 Precision

Although there are apparent differences between the numbers of replicate samples collected for precision estimates, the plan as stated is appropriate to the media sampled. A higher percentage of replicate air, soil and sediment samples are collected than are collected for water because:

- Air samples collected on Tenax or foam plugs cannot be split.
- Soil and sediment samples have not been analyzed for the compounds of interest as extensively as water or air samples.
- Extensive precision and accuracy data are available for water sample analysis.

8.1.2 Accuracy

There are differences also in the numbers of external QC samples provided to each analytical laboratory and the manner in which they are provided. More external QC samples are provided to air analysis subcontractors than to water, soil and sediment subcontractors because:

- The air analysis subcontractors cannot readily prepare spiked Tenax cartridges or foam plugs in-house; this limits their internal QC measures.
- The water, soil and sediment analysis programs designed by EPA incorporate extensive internal QC measures which can be correlated for estimating accuracy.

Spiked Tenax cartridges and foam plugs can be provided as truly blind QC samples; the Quality Control Check sample vials used for water, soil, sediment and biota QC samples cannot. The Quality Control Check samples could be spiked into reagent water or replicate samples at the Sample Bank to provide blind QC samples; however, it is felt that some of the compounds of interest might not

be stable at the concentrations of interest if diluted in this way. Since the internal QC program provides other measures of accuracy, it has been decided to provide the QC Check Sample vials to the analytical subcontractors even though they are recognizable as QC samples. The following sections describe precision and accuracy measures planned for each media sampled and analyzed.

8.2 AIR MONITORING

8.2.1 Precision

Measurement precision for volatile organics, pesticides and related chemicals is based on the use of duplicate sampling trains in the living area of the base sites on each monitoring day. Approximately 10 percent of the Tenax tubes and 15 percent of the polurethane foam plugs will be collected in duplicate by the sampling subcontractor and analyzed by different analytical subcontractors.

Intralaboratory measurement precision for each analytical laboratory will be determined from its results on the first 12 duplicate sets analyzed, and from remaining duplicates analyzed during the program.

Interlaboratory measurement precision will be determined by splitting duplicate sample sets between the analytical subcontractor and the referee laboratory after the subcontractor has analyzed 12 duplicate sets. In each subsequent monitoring day's shipment to an analytical subcontractor, one set of duplicate samples will be split between the subcontractor and referee; the remaining duplicate sets will be sent to the subcontractor.

Intralaboratory precision for analysis only will be determined from the results on the spiked duplicates described in Section 8.2.2 and from each laboratory's internal QC data.

Measurement precision for trace metal analyses will be estimated from the duplicate high-volume samples collected at two of the base sites; these will constitute 18 percent of the total high-volume samples. One laboratory will perform all the ICAP analyses so that it will not be necessary to determine interlaboratory measurement precision.

Intralaboratory precision for analysis only will be determined from the results on the spiked filters described in Section 8.2.2 and from the laboratory's internal QC data.

8.2.2 Accuracy

Analytical accuracy for volatile organics will be determined from the analysis of Tenax tubes spiked with chloroform, carbon tetrachloride, 1,1,2-trichloroethylene, 1,1,2,2-tetrachloroethylene (perchloroethylene), benzene, and chlorobenzene. The spiked tubes will be prepared by one subcontractor laboratory and verified by a different subcontractor laboratory, neither of whom is performing any analyses for the program. Two spiked Tenax tubes will

be inserted by GCA in each shipment of approximately 40 collected samples to an analytical subcontractor.

Spiked foam plugs containing lindane, hexachlorobenzene, hexachlorocyclopentadiene, 1,2,3,4-tetrachlorobenzene, 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, 1,3,5-trichlorobenzene, 2,4,5-trichlorophenol, and pentachlorobenzene will be used to estimate analytical accuracy for pesticides and related organics. These external QC samples will be prepared by HERL/RTP and provided to GCA for insertion in the sample load; two spiked plugs from each prepared lot will be shipped back to HERL for confirmatory analysis; two spiked plugs will be included in each shipment of approximately 40 collected samples to an analytical subcontractor.

Analytical accuracy for trace metal analysis will be determined from the analysis of spiked glass-fiber filter strips provided to GCA by EMSL/RTP. Two filter strips will be included with each shipment of approximately 50 collected filters.

Accuracy of sampling will be determined from an independent audit of the sampler flow rates for all types of samples collected. EMSL/RTP personnel will audit flowrates on the pumps used for Tenax, foam and Hi Vol filter sample collection shortly after all monitoring sites are on-line. Subsequent audits will be performed at no more than 6-week intervals for the duration of the monitoring program.

8.3 WATER MONITORING

8.3.1 Precision

Measurement precision for water samples from basement sumps, drinking water supplies, sewers and drains, surface and groundwaters will be estimated from the differences between triplicate samples collected in the field for each water type. Approximately 5 percent of all water samples will be collected in triplicate; volume considerations may become important in choosing sites for replicate collection from sumps and groundwaters. These samples, except groundwaters, will be collected by one sampling subcontractor and analyzed by several different analytical subcontractors. Groundwater sampling will be conducted by the supervisory geologist.

Intralaboratory measurement precision for each laboratory will be estimated from its analysis of duplicates from these triplicate samples.

Interlaboratory measurement precision will be determined by sending the third replicate from each triplicate set to the referee laboratory, EMSL/Cincinnati.

Intralaboratory precision for analysis only will be determined from the results of carrying two replicate aliquots from every tenth sample through the entire analytical procedure.

8.3.2 Accuracy

Analytical accuracy for water samples will be estimated from each subcontracting laboratory's results on Quality Control Check samples provided to GCA by EMSL/Cincinnati for insertion in the sample load as independent checks on accuracy. One QC check sample will be included in each group of approximately 20 collected samples shipped to an analytical laboratory. Surrogate recovery will also be correlated with performance on Laboratory Control Standards (LCS) to provide information on the accuracy of laboratory results.

8.4 SOIL AND SEDIMENT MONITORING

8.4.1 Precision

Measurement precision for soil and sediment samples will be estimated from the analysis results of triplicate samples collected at 10 percent of the sampling locations. These samples will be collected by one sampling subcontractor and analyzed by different analytical subcontractors. Triplicates will not be collected for semivolatiles during the initial methods study.

Intralaboratory measurement precision for each laboratory will be estimated from its analysis of duplicates from these triplicate samples.

Interlaboratory measurement precision will be determined from analysis of the third replicate in each triplicate set by the referee laboratory, EMSL/Cincinnati.

Intralaboratory precision for analysis only will be estimated from the results of carrying two replicate aliquots from every tenth sample through the entire analytical procedure.

8.4.2 Accuracy

Analytical accuracy for soil and sediment sampling will be estimated from each subcontracting laboratory's results on Quality Control Check Samples provided to GCA by EMSL/Cincinnati for insertion in the sample load. One QC check sample will be included with each shipment to an analytical subcontractor of approximately 20 collected samples. Surrogate recovery will also be correlated with performance on Laboratory Control Standards (LCS) to provide information on the accuracy of laboratory results.

8.5 DIOXIN MEASUREMENTS - AIR, WATER, SOIL AND SEDIMENT SAMPLES

Selected samples from all media will be analyzed for dioxins by one subcontractor laboratory; all positive results will be confirmed by the referee laboratory, HERL/RTP. Due to the unique toxicological properties of TCDD and the very low concentration (ppt to ppb) levels expected to be found, the quality assurance program includes 20 percent QA samples with each lot of collected samples. These QA samples include blank or control samples and spiked samples prepared by HERL/RTP and provided to GCA for inclusion with collected samples.

8.5.1 Precision

Measurement precision for dioxin in each media sampled will be estimated from the duplicate samples collected as described in the preceding sections for air, water, soil and sediment.

Intralaboratory measurement precision will be determined from the subcontractor laboratory's analysis of the collected suplicate samples. Since one subcontractor is analyzing all samples it will not be necessary to establish interlaboratory precision.

Intralaboratory precision for analysis only will be estimated from results on duplicate spiked samples and the laboratory's internal QC data.

8.5.2 Accuracy

Analytical accuracy will be determined from the analysis of spiked samples inserted in the sample load by GCA; two spiked samples and two blank or control samples will be included in each shipment of approximately 20 collected samples.

8.6 BIOMONITORING PROGRAM

8.6.1 Precision

Overall measurement precision cannot readily be estimated for biological samples since duplicates cannot be provided. However, the subcontracting analytical laboratory will prepare double quantities of approximately 10 percent of the vegetation, mouse and dog hair samples for metals analyses and send half of these prepared quantities to the referee laboratory, ERL/Corvallis. Extracts of approximately 10 percent of mouse, crayfish and earthworm tissue samples will be prepared in double quantities also. These prepared extracts and approximately 10 percent of the potato and oatmeal samples will be analyzed both by the subcontractor laboratory and the referee laboratory, ERL/Duluth.

Intralaboratory precision for analysis only will be estimated from the results of carrying two replicate aliquots from every tenth sample through the entire analytical procedure.

8.6.2 Accuracy

Analytical accuracy for biota sampling will be estimated from each subcontracting laboratory's results on Quality Control Check Samples provided to GCA by EMSL/Cincinnati for insertion in the sample load. One QC check sample will be included with each shipment of approximately 20 collected samples. Laboratory internal QC data on Laboratory Control Standards and surrogate recovery will be correlated to provide information on expected accuracy.

8.7 PRECISION AND ACCUPACY EQUATIONS

The precision of analytical results on duplicate collected samples shows the variability present in the measurement system; the accuracy of analytical results on known value QC samples shows the bias present in the analytical measurement. The equations used to estimate precision and accuracy are given in the following sections.

8.7.1 Intralaboratory Precision Equations

Intralaboratory measurement precision for each subcontractor laboratory will be estimated from its analysis of duplicate collected samples. For each duplicate sample we assume that the following mathematical model holds:

Y_i and X_i are independent, normally distributed variables both with mean μ_i and standard deviation σ. We assume the mean μ_i can change from day to day but σ is constant.

The intralaboratory precision is quantified by σ and it is estimated by computing the standard deviation of the differences divided by $\sqrt{2}$. The following equations are used:

Difference Between Duplicates

$$d_i = Y_i - X_i \tag{1}$$

where Y_i = concentration measured by duplicate 1,

X_i = concentration measured by duplicate 2 and

d_i = difference between duplicate analyses.

$$\overline{D} = \frac{1}{k} \sum_{i=1}^{k} d_i \tag{2}$$

where $\overline{D}$ = monthly mean difference

k = number of duplicates/month.

Standard Deviation of Differences (S_d)

$$S_d = \sqrt{\frac{1}{(k-1)} \left[\sum_{i=1}^{k} d_1{}^2 - \frac{1}{k} \left(\sum_{i=1}^{k} d_i \right)^2 \right]} \tag{3}$$

Estimate of the standard deviation of a single y or x value (S_y,S_x)

For a single y or x value the estimate of the standard deviation is $\frac{S_d}{\sqrt{2}}$

95% Probability Limits for a Single y or x Value

$$\text{Upper 95\% Probability Limits} = y \text{ or } x + 1.96 \frac{S_d}{\sqrt{2}} \quad (4)$$

$$\text{Lower 95\% Probability Limits} = y \text{ or } x - 1.96 \frac{S_d}{\sqrt{2}} \quad (5)$$

8.7.1.1 Intralaboratory Precision Reporting

For each set of duplicates analyzed, the following will be reported on a monthly basis classified by pollutant, media analyzed and analytical laboratory:

y values, x values, differences

$\overline{D}$, monthly mean difference.

$\frac{S_d}{\sqrt{2}}$, standard deviation of a single value

$\pm 1.96 \frac{S_d}{\sqrt{2}}$, Upper and Lower 95% Probability Limits

8.7.2 Interlaboratory Precision Equations

Interlaboratory measurement precision for each analytical subcontractor will be estimated from the analysis of duplicate collected samples by the subcontractor and an EPA referee laboratory. The variability between these measurements is the interlaboratory precision. The mathematical model appropriate here is that y_i and x_i are independent, normally distributed variables both with mean μ_d and standard deviation σ. $\overline{D}$ is an estimate of the mean μ_d.

Ideally $\mu_d = 0$. If this is not true then there is a bias (on the average the subcontractor's values do not equal the referee laboratory's values) and $\overline{D}$ is a point estimate of this bias. The standard deviation σ_d is the parameter used to quantify the interlaboratory precision and is estimated by the sample standard deviation S_d which is calculated using the following equations:

Difference Between Duplicates

$$d_i = Y_i - X_i \quad (6)$$

where Y_i = subcontractor analysis result,

X_i = referee laboratory analysis result and

d_i = difference between duplicate analyses.

$$\overline{D} = \frac{1}{k} \sum_{i=1}^{k} d_i \tag{7}$$

where $\overline{D}$ = monthly mean difference

k = number of duplicates/month.

Standard Deviation of Differences (S_d)

$$S_d = \sqrt{\frac{1}{(k-1)} \left[\sum_{i=1}^{k} d_i^2 - \frac{1}{k} \left(\sum_{i=1}^{k} d_i \right)^2 \right]} \tag{8}$$

Assuming a normal distribution, 95 percent of the differences, d, are estimated to fall between

$$\overline{D} + 1.96\ S_d \text{ and } \overline{D} - 1.96\ S_d \tag{9}$$

These values can be used as control limits on the d's if so desired.

8.7.2.1 Interlaboratory Precision Reporting

For each set of duplicates analyzed, the following will be reported on a monthly basis classified by pollutant, media analyzed and analytical laboratory:

y values, x values, difference

$\overline{D}$, monthly mean difference = point estimate of bias

S_d, standard deviation of differences

$\pm 1.96\ S_d$, Upper and Lower Control Limits

8.7.3 Accuracy Equations

Analytical accuracy for each subcontractor laboratory will be estimated from its analysis results on external QC samples whose true value is known. The mathematical model appropriate here is that values of d_j are independently distributed with mean μ_d and standard deviation σ_d. If the subcontractor is accurate then

$$d_j = Y_i - X_j = 0 \text{ identically}$$

and

$$\mu_d = 0 \text{ identically.} \tag{10}$$

If $d_j \neq 0$ and if $\mu_d \neq 0$ the subcontractor's results are not completely accurate and a bias exists. We define μ_d as the bias; its point estimate is $\overline{D}$. The following equations are used to calculate $\overline{D}$.

Difference from True Value, or Bias

$$d_j = Y_j - X_j \tag{11}$$

where Y_j = subcontractor analysis result,

X_j = true value, and

d_j = difference from true value.

$$\overline{D} = \frac{1}{n} \sum_{j=1}^{n} d_j \tag{12}$$

where $\overline{D}$ = monthly mean difference = point estimate of bias

n = number of external QC samples analyzed/month.

95 Percent Confidence Interval

This point estimate can be expanded to an interval estimate or confidence interval:

$$\overline{D} \pm t \frac{S_d}{\sqrt{n}}$$

where

$$S_d = \sqrt{\frac{1}{(n-1)} \left[\sum_{j=1}^{n} d_j^{\,2} - \frac{1}{n} \left(\sum_{j=1}^{n} d_i \right)^2 \right]} \tag{13}$$

and t is the appropriate value to produce the confidence interval with desired confidence level. For example, if $n \geq 30$ and a 0.95 confidence interfal level is desired, then t = 1.96. If the confidence interval contains zero, we can say with 95 percent confidence that the difference is caused by random variation and not by a bias in the measurement.

8.7.3.1 Accuracy Reporting

For each external QC sample analyzed, the following will be reported on a monthly basis classified by pollutant, media analyzed and analytical laboratory:

true value
differences
$\overline{D}$, monthly mean difference = point estimate of bias

$\overline{D} \pm \frac{1.96\ S_d}{\sqrt{n}}$, Upper and Lower 95% Confidence Limits

9.0 DATA MANAGEMENT SYSTEM

9.1 GENERAL INFORMATION

The purpose of the data management system is to collect and store all data generated as part of the Love Canal Study and to provide basic reports of the monitoring results.

Development of a system to manage and report the sampling data will require activity in four general areas:

- Defining data flow and traceability
- Preparation of data coding forms
- Creation of a Manual of Codes and Data Coding Procedures
- Development of handling and reporting software

The key features of the processing system include:

- Editors for all cards entering the system
- Maintenance of the raw data in a multi-record card format
- Conversion of a completed sample to a single, updatable record at the verification level
- Capability to produce data summaries broken down by any field on the sample card
- Generation of tapes of raw data, verified data, and validated data for use by EPA

9.2 DATA DESCRIPTION

9.2.1 Data Flow

Figure 9-1 shows the flow of data through the system. The maintenance of three separate data files for raw, verified and validated data should be noted.

The difference among these files is the level of review involved in ensuring accuracy of the data. The raw data file represents data which have received a cursory review to confirm that the data have been provided in the proper format. At the raw data level, all key data are correct and all mandatory data supplied.

At the verified data level, the information has all been reviewed by the supplying group (e.g., the analytical laboratories) and any errors in transcription, keying, or processing corrected.

The validated data file corresponds to a much higher level of review. All QC runs, both internal and external, are reviewed in relation to the analytical concentrations and corrections to the data made. The data in this file will be supplied to EPA for further review.

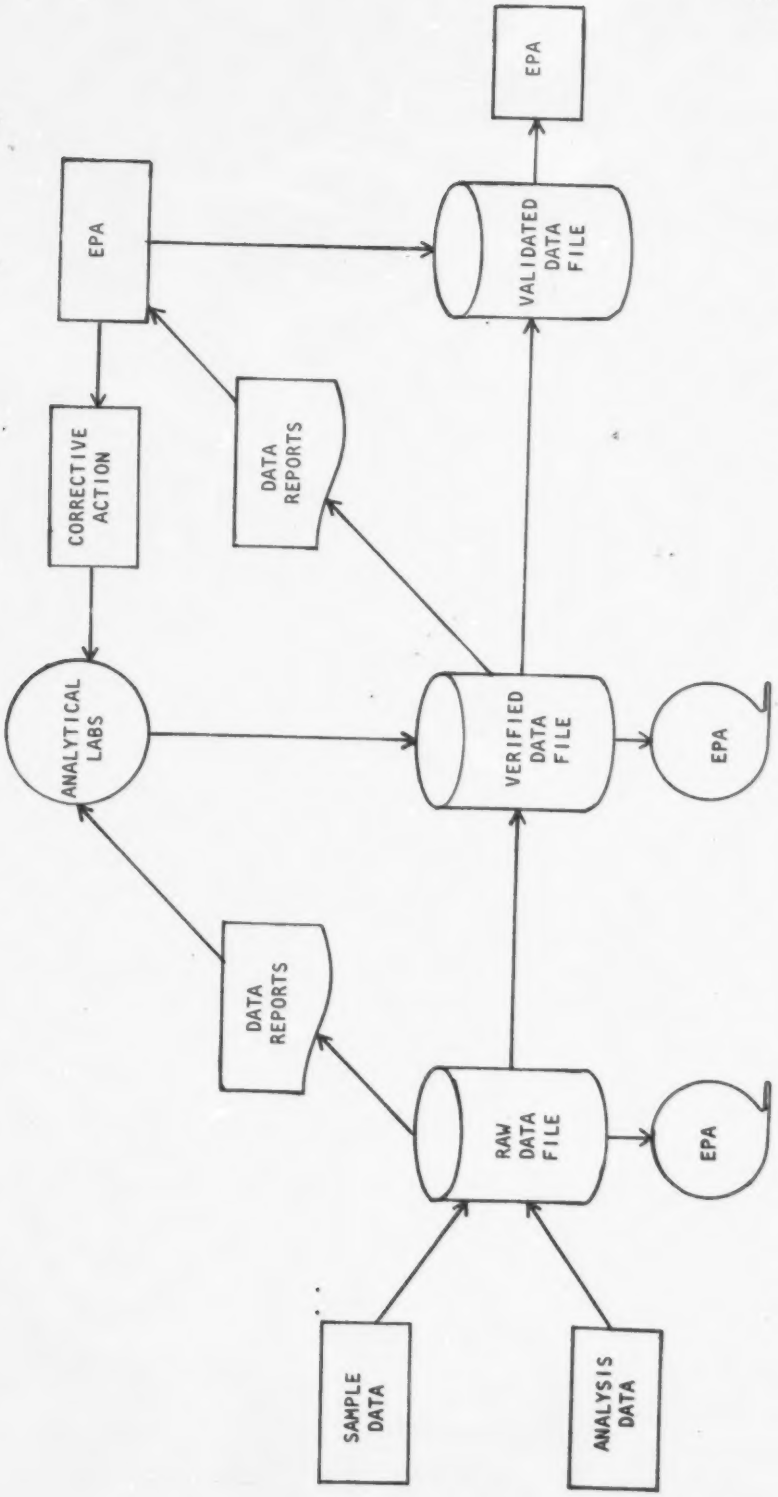


Figure 9-1. Data flow diagram.

9.2.2 Input Data

Input of all data to the system will be effected by computer cards. The data to be stored in the system have been categorized into two areas:

- Sample data
- Analytical data

In addition, the following special information is required:

- Duplicate (QA/QC) cross-reference data
- Verification data
- Validation data

1. Sample data - Sample data include information such as sample type, location, time, date, meteorology, needed instrument readings, and tag numbers. The sample data coding form will originate in the sample bank, using data supplied by the field technician supervising the sample collection. The master sample number will be added to the form along with the analytical lab to which the sample is being sent and other appropriate custody or tag numbers.

   This sample data form, which includes six card formats, will be keypunched and entered into the data handling system. It will then serve as the basis for generating a tag number/custody number/master ID cross-reference system which will be provided to the sample bank on a weekly basis. This form will also serve as a basis for generating deliquency reports for analytical samples which are overdue.

Analytical Data

A form specific to each medium and type of analyte will be completed for each sample by the analytical lab. The labs will also complete coding forms for QC samples and procedures which they provide. These samples will be entered into the system by assigning a sample number from a reserved series and providing proper comment for the data reports.

These forms will be sent to the appropriate EPA lab and to GCA. At GCA, they will be keypunched. An expandable three-digit code for each pollutant will be used by GCA in the data management system; cross-reference to the Chemical Abstracts Registry Number will be retained.

Duplicate Cross-reference Data

The Sample Bank will submit duplicate or triplicate samples to analytical laboratories as part of the QA/QC program. Each time this is done, a special form giving the replicate sample ID numbers, plus any comments as to why the sample was chosen, will be coded and sent to GCA for keypunch. The replicate samples will then be reported adjacent to the first sample with an appropriate notation in the verified and validated files.

Verification Procedures

GCA will provide a raw data listing to each analytical lab and other responsible labs, listing sample information together with analysis data for samples analyzed by that lab. Possible data problems such as missing values, high concentrations, low surrogate recoveries, etc., will be highlighted by GCA on this computer listing. The labs will specify corrective action to be applied to the raw data file and GCA will then code forms to accomplish these corrections. It is expected that the principal actions will be "ADD," "DELETE," or "REPLACE" and the form will be set up to handle these functions. More complex directions, such as "double the value," will require special programmer actions. This form will serve as a record of who made changes, and it will include any notation as to why the changes were necessary.

Validation Procedures

Final instructions for creation of the validated file are expected to be relatively complex and the form of the instructions, other than a "delete" function, will most likely have to be applied on a case-by-case basis. Hence, no specific form is envisioned for this purpose. Information will be collected from responsible parties and appropriate software developed and applied to create the validated data file.

9.2.3 Output Data

A number of reports will be generated from the raw data, the verified data, and the validated data files. Raw data files, verified data files, and validated data will be transferred to RTP for their use. The reports to be developed are described below.

ID Number Cross-reference

Each sample will have from four to eight different tag/custody numbers associated with it. The master sample number will serve as the basis for cataloging all of these numbers. The ID Number Cross-reference report will provide all necessary cross-referencing to determine the master number if some other number (e.g., sample tag number) is known. It will be updated weekly and stored at GCA and the Sample Bank; it will also be kept in a disk file for checking the ID of new data entries.

Data Summaries

A listing of all data received during the last processing period (expected to be 1-week intervals) will be generated and sent to the appropriate EPA and analytical labs for review. Each file will have a header describing the data file accessed plus other pertinent information.

These summaries will be generated in three ways:

- By sample
- By laboratory and sample
- By sample, pollutant, and location (verified data only).

Other summaries can be developed if requested.

Alert Reports

An alert level will be determined for each pollutant and a report of all analytes in each sample which exceed this value will be generated. This report will provide a focus for special attention to identify bad data or actual high concentration areas.

Delinquency Report

For each lab, the computer will generate a list of all samples for which it has not provided analysis data within the prescribed time period. This report will serve as the basis for a letter to the lab, reminding it of these requirements.

Intermediate and Final Data Transfer

The raw data, verified data, and validated data files will be transferred to RTP in formats readable by their UNIVAC machine. Close coordination will be maintained with RTP personnel to assure that their needs are met.

9.3 DATA MANAGEMENT INTERNAL QC PROCEDURES

The key components of the data management QC program include the following item:

- Development of uniform data reporting forms
- Issuance of data reporting/codes manuals to all parties
- Keypunch verification of all input data
- Online editing of all input data fields with error reports being issued for review.
- Log-in of all data report forms received at GCA.

10.0 SYSTEM AND PERFORMANCE AUDITS

10.1 GENERAL INFORMATION

Throughout the program, audits will be conducted by EPA personnel and by GCA personnel implementing EPA's program plan. Section 8.0 of this plan describes performance audit activities. In addition, GCA will audit its own operation of the Sample Bank and data management system and anticipate unannounced audits by EPA or a third party.

10.2 SYSTEM AUDITS

10.2.1 Sample Collection Audits

The GCA QA Manager will audit the overall QA system for sample collection, storage, and transfer just before or just after residential air sampling starts. At this time, all units involved in sampling activity, except the geotechnical work, should be operational. The intent of this audit is to critically review the entire onsite operation to determine the need for any corrective action early in the program. Additional audits will be conducted during the sampling program.

GCA will maintain a Sampling QA Coordinator onsite during sample collection to monitor the sampling subcontractor's activities in a general way, provide technical assistance and corrective action suggestions to the sampling subcontractor, and implement performance audits on sampling as needed. The frequency of system audits by the QA Manager will be determined, in part, from input from GCA's Sampling QA Coordinator and other GCA field personnel.

10.2.2 Geotechnical Study System Audit

The GCA QA Manager will audit at least once during active geotechnical work to evaluate the QA/QC measures in use for this aspect of the program. This onsite audit will also provide opportunity for corrective action follow-up from previous sampling audits.

GCA will maintain a geotechnical QA Coordinator onsite during this project activity who will coordinate with all the geotechnical subcontractors, providing technical assistance and corrective action suggestions.

10.2.3 Chain-of-Custody Audits

It is anticipated that NEIC personnel will conduct a system audit of the custody system in use on this project. GCA QA personnel will trace specific samples through the system from time to time.

10.2.4 Analytical Audits

Site visits to subcontractor analytical labs will be made by EPA and GCA personnel on a monthly basis during active analytical work. Frequent communication between GCA's analytical QA coordination and each analytical subcontractor will be maintained throughout the program.

10.2.5 Data Management Audits

GCA's Analytical QA Coordinator will audit the data management system by tracing the flow of specific samples through the system. In particular, the ability of the system to correctly identify a sample from any one of its identification numbers will be checked. The copies of the Sample Bank Logbook pages transmitted to GCA on a weekly basis will be the basis for these performance checks. From time to time, erroneous input information will be used to audit the edit check system.

10.3 PERFORMANCE AUDITS

10.3.1 Sample Collection Audits

EPA personnel will conduct flow rate audits on air sampling equipment just before residential air sampling starts and at intervals not to exceed 6 weeks thereafter. The field blanks collected for all media throughout the program audit sample handling.

10.3.2 Analytical Audits

Section 8.0 of this volume describes the planned accuracy checks on the analytical subcontractors' work.

11.0 CORRECTIVE ACTION PROCEDURES

GCA/Technology Division maintains a closed-loop corrective action system and will require that its subcontractors do, also. The purpose of a closed-loop system is to ensure that any quality problem is reported to a person responsible for correcting it who is part of a system ensuring action and follow up on all reported problems. Each subcontractor shall identify the person responsible at each stage of his operations.

11.1 DETERMINING THE NEED FOR CORRECTIVE ACTION

The need for corrective action may be identified by standard QC procedures, control charts, performance or system audits. Often the experience of a field technician or an analyst will be most valuable in alerting him to malfunctioning equipment or suspicious data.

To promptly and uniformly identify the need for corrective action, control limits for equipment and analytical results are stated throughout this program. The control limits may be absolute differences from a meter reading or they may be based on the standard deviation of analytical results, as in control charts.

Each subcontractor is required to submit internal QC procedures which include control limits and corrective actions to be taken if these limits are exceeded. These control limits are stated for each measurement method and are presented in tabular form in Section 6, Sampling Internal QC Checks, and Section 7, Analytical Internal QC Checks, of this QA Plan. Each media sampled or analyzed is covered in a separate table for easy use by a field or laboratory technician.

11.2 IMMEDIATE CORRECTIVE ACTION

Equipment and instrument malfunctions are most amenable to on-the-spot, immediate corrective actions. The internal QC tables are working tools which identify appropriate immediate corrective actions to be taken when a control limit has been exceeded; they provide the framework for uniform actions as part of normal operating procedures. The actions taken should be noted in field or laboratory notebooks but no other formal documentation is required, unless further corrective action is necessary. These on-the-spot corrective actions are an everyday part of the QA/QC system; they help avoid the collection of poor quality data.

If the problem is not solved in this way, more formalized long-term corrective action may be necessary. The following subsection discusses GCA's closed-loop system for effectively handling these long-term actions.

11.3 LONG-TERM CORRECTIVE ACTION

The need for this action may be identified by standard QC procedures, control charts, performance or system audits. Any quality problem which cannot be solved by immediate corrective action falls into the long-term category.

The essential steps in a closed-loop corrective action system are:

- Identify and define the problem.
- Assign responsibility for investigating the problem.
- Investigate and determine the cause of the problem.
- Determine a corrective action to eliminate the problem.
- Assign and accept responsibility for implementing the corrective action.
- Establish effectiveness of the corrective action and implement it.
- Verify that the corrective action has eliminated the problem.

Documentation of the problem is important to the system. A Corrective Action Request Form is filled out by the person finding the quality problem. This form identifies the problem, possible causes and the person responsible for action on the problem. The responsible person may be an analyst, field team leader, project QA coordinator or the QA Manager. If no person is identified as responsible for action, the QA Manager investigates the situation and determines who is responsible in each case.

The Corrective Action Request Form (CA form) is shown in Figure 11-1 and includes a description of the corrective action planned, the date it was taken, and space for follow-up. The QA Manager checks to be sure that initial action has been taken and appears effective and, at appropriate later dates, checks again to see if the problem has been fully solved. The QA Manager receives a copy of all CA forms and enters them in the Corrective Action Log. This permanent record documents follow-up and makes any quality problems visible to management; the log may also prove valuable for similar problems and their solutions.

The QA Manager maintains an active follow-up file, filing the CA forms in date order. If the follow-up on the indicated date shows a need for other action or continued follow-up, the action to be taken is identified on the form and it is filed under the date for the next follow-up. This system has proved quite effective in handling sequential types of corrective action since it brings the CA form to the QA Manager's attention at a time appropriate to check on the next stage of corrective action. The same form can follow a problem until it has been solved.

Originator _____ Date _____

Person Responsible for Replying _____ Contract Involved _____

Description of problem and when identified: _____

_____

_____

_____

_____

State cause of problem, if known or suspected: _____

_____

_____

Sequence of Corrective Action: (If no responsible person is identified, bring this form directly to QA Manager.)

State Date, Person, and Action Planned:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

CA Initially Approved By: _____ Date: _____

Follow-up Dates _____

Final CA Approval By: _____ Date: _____

Information copies to:

RESPONSIBLE PERSON: _____

QA MANAGER: _____

DEPARTMENT MANAGER: _____

Figure 11-1. Corrective Action Request Form.

Subcontractors are not required to follow this system exactly or use the pictured CA form. They are required to have a functioning system which ensures that quality problems are corrected and follow-up is provided to prevent recurrence of the problem. Subcontractors shall describe their internal system, how it operates in their specific project activity, and the person responsible for corrective action at each stage in their operations. They shall maintain a corrective action log for this project and include it in the project document inventory returned to GCA on completion of project work.

ATTACHMENT 1

SAMPLING SUBCONTRACTOR'S QA PLAN FORMAT SUGGESTIONS

Requirements for Sampling Subcontractor's QA Plan

1. Follow format given in EPA's ORD "Guidelines and Specifications for Preparing Quality Assurance Project Plans". A copy of this document will be provided by GCA.

2. Follow the outline for GCA's overall QA Project Plan, addressing each topic as it refers to your specific operation. See attached sample outline for subcontractor's QA Plan.

3. Document Control heading for Appendix A (on upper right-hand corner each page).

Appendix A, Section 1.1.1
Revision 0
Page of

Subcontractor's
QA Project Plans
for
Multimedia Sampling at Love Canal

Outline

Section 1.0 Project Description and Organization

Section 2.0 Major Project Elements

Section 3.0 QA Objectives - State expected precision and accuracy to be achieved by each sampling technique, if possible to do so.

Section 4.0 Document Control Procedures - Overall framework, numbering system, sample tags, Custody Forms, Log Books, Data Sheets provided by GCA. State your internal operation of the system, identifying responsible person as Document Control Officer.

Section 5.0 Chain of Custody - Same as 4.0.

Section 6.0 Sampling Internal QC checks - Provide a table for each media sampled which lists operational checks for each sample collection technique. Control limits for each operational check should be provided with the corrective action to be taken if control limits are exceeded.

Section 7.0 Data Reporting Management System-Standardized data forms will be provided by GCA - both field data sheets and encoding forms for the data management system. Internal operation of the system, and data review before reporting should be described.

Section 8.0 Corrective Action Procedures - State how corrective actions will be implemented in the field - identify responsible personnel. The corrective actions should have been identified in Section 6.0.

Appendix A Sampling Procedures

Part 1. Sample Collection Procedures

Provided by GCA - includes field data sheets. Calibration of sampling equipment forms part of operating procedure - subcontractor provides for his equipment.

Part 2. Sampling Equipment Maintenance/Troubleshooting Procedures

QA Project Plan
For
Multimedia Monitoring at Love Canal

Appendix A Sampling Procedures

PART 1. SAMPLING PROCEDURES

1.0 Air Sampling

- 1.1 Overview
- 1.2 Sampling Procedures
  - 1.2.1 Volatile Organics
  - 1.2.2 Pesticides/Related Organics
  - 1.2.3 Metals
- 1.3 Meteorological Measurements
  - 1.3.1 Residential
  - 1.3.2 Meteorological Station

2.0 Pollutant Air Transport Sampling

- 2.1 Locations/Frequency/Pollutant Class
- 2.2 Sampling Procedures
  - 2.2.1 Volatile Organics
- 2.3 Meteorological Measurements

3.0 Residential Water Sampling/Sumps

- 3.1 Locations/Freqnency/Pollutant Class
- 3.2 Sampling Procedures
  - 3.2.1 Volatile Organics
  - 3.2.2 Semivolatile Organics/Pesticides
  - 3.2.3 Inorganics
  - 3.2.4 Radioactivity

4.0 Drinking Water Sampling

- 4.1 Location/Frequency/Pollutant Class
- 4.2 Sampling Procedures
  - 4.2.1 Volatile Organics
  - 4.2.2 Semivolatile Organics/Pesticides
  - 4.2.3 Inorganics

5.0 Sewer and Drain Water Sampling

- 5.1 Location/Frequency/Pollutant Class
- 5.2 Sampling Procedures
  - 5.2.1 Volatile Organics
  - 5.2.2 Semivolatile Organics/Pesticides
  - 5.2.3 Inorganics
  - 5.2.4 Radioactivity

Appendix A Sampling Procedures (Cont'd)

6.0 Surface Water Sampling

- 6.1 Location/Frequency/Pollutant Class
- 6.2 Sampling Procedures
  - 6.2.1 Volatile Organics
  - 6.2.2 Semivolatile Organics/Pesticides
  - 6.2.3 Inorganics

7.0 Ground Water Sampling

- 7.1 Location/Frequency/Pollutant Class
- 7.2 Sampling Procedures
  - 7.2.1 Volatile Organics
  - 7.2.2 Semivolatile Organics/Pesticides
  - 7.2.3 Inorganics
  - 7.2.4 Total Organic Carbon (TOC)
  - 7.2.5 Total Organic Halogens (TOX)

8.0 Soil Sampling

- 8.1 Location/Frequency/Pollutant Class
- 8.2 Sampling Procedures
  - 8.2.1 Volatile Organics
  - 8.2.2 Semivolatile Organics/Pesticides
  - 8.2.3 Inorganics
  - 8.2.4 Radioactivity

9.0 Sediment Sampling

- 9.1 Location/Frequency/Pollutant Class
- 9.2 Sampling Procedures
  - 9.2.1 Volatile Organics
  - 9.2.2 Semivolatile Organics/Pesticides
  - 9.2.3 Inorganics
  - 9.2.4 Radioactivity

10.0 Biota Sampling Plan

- 10.1 Location/Frequency/Species Collected
- 10.2 Trapping/Handling Procedures
  - 10.2.1 Small Animals
  - 10.2.2 Larger Animals

Appendix A Sampling Procedures (Cont'd)

PART 2. SAMPLING EQUIPMENT MAINTENANCE/TROUBLESHOOTING PROCEDURES

11.0 Air Sampling Equipment

- 11.1 Tenax Sampling Trains/Pumps
- 11.2 Polyurethane Foam Sampling Trains/Pumps
- 11.3 Hi Vol Sampling Trains/Pumps
- 11.4 Flow Recorders
- 11.5 Elapsed Time Meters
- 11.6 Wet Bulb/Dry Bulb Thermometers

12.0 Meteorological Equipment

- 12.1 Wind Speed/Direction Monitor
- 12.2 Continuous Temperature/Humidity Recorder
- 12.3 Recorders/Other

13.0 Water Sampling Equipment

- 13.1 Dippers
- 13.2 Bailers
- 13.3 Pumps/Peristaltic, Other
- 13.4 Other

14.0 SOIL/SEDIMENT SAMPLING EQUIPMENT

- 14.1 Augers
- 14.2 Soil Corers
- 14.3 Eckman Dredges
- 14.4 Other

ATTACHMENT 2

ANALYTICAL SUBCONTRACTORS' QA PLAN FORMAT SUGGESTIONS

GCA/TECHNOLOGY DIVISION
A DIVISION OF GCA CORPORATION
Bedford, Massachusetts 01730

ATTACHMENT 2

SUGGESTED FORMAT FOR ANALYTICAL SUBCONTRACTORS' QUALITY ASSURANCE PLANS

The Quality Assurance Plans prepared by the Subcontractors should be in formats consistent with each other as well as with the overall program QA Plan such that the Subcontractors' Plans can be incorporated into the Prime Contractor's plan as appendices. Therefore, it is recommended that the Subcontractor follow the format listed below:

1. Outline for Prime Contractor's overall QA Project Plan, addressing each topic as it refers to your specific operation. See attached sample outline for Subcontractor's QA Plan.

2. Document Control heading (on upper right-hand corner of each page). These may be used as four-line headings, if preferred.

EXAMPLE 1:
Appendix B, Section 1.1.1
Revision 0
Page of

EXAMPLE 2:
Appendix Q13, Section 1.1.1
Revision 0
Page of

SUBCONTRACTOR'S QA PROJECT PLANS FOR
ANALYSIS OF SAMPLES FROM LOVE CANAL

Outline

1.0 Project Description and Organization

2.0 Major Project Elements

3.0 QA Objectives - State expected precision and accuracy to be achieved by each analytical method in each media analyzed.

4.0 Document Control Procedures - Overall framework, numbering system, sample tags, Custody Forms, Log Books, Data Sheets provided by Prime Contractor. State your internal operation of the system, identifying responsible person as Document Control Officer.

5.0 Chain of Custody - Same as 4.0

6.0 Analytical Internal QC Checks - Provide a table for each media (air, water, etc.) analyzed which lists operational checks for each analytical method. Control limits for each operational check should be provided with the corrective action to be taken if control limits are exceeded.

7.0 Data Reporting Management System - Standardized data forms will be provided by Prime Contractor - both analytical data sheets and encoding forms for the data management system. Internal operation of the system, and data review before reporting should be described.

8.0 Corrective Action Procedures - State how corrective actions will be implemented in the laboratory - identify responsible personnel. The corrective actions should have been identified in Section 6.0.

Appendix B Analytical Procedures

Part 1. Analytical Methods. Provided by Prime Contractor.

Includes analytical data sheets. Calibration of sampling equipment forms part of operating procedure--subcontractor provides for his equipment, unless given in analytical method.

Appendix B Analytical Procedures (continued)

Part 2. Analytical Equipment Maintenance/Troubleshooting Procedures

GC/MS

GC/ECD

Analytical Balances

AA--Cold Vapor Hg, Furnace Techniques

pH and Selective Ion Meters

Technician Autoanalyzer, If Used

Other Equipment

ATTACHMENT 3

GEOTECHNICAL SUBCONTRACTORS' QA PLAN
FORMAT SUGGESTIONS

GCA/TECHNOLOGY DIVISION
A DIVISION OF GCA CORPORATION
Bedford, Massachusetts 01730

ATTACHMENT 3

SUGGESTED FORMAT FOR GEOTECHNICAL SUBCONTRACTORS' QUALITY ASSURANCE PLANS

The Quality Assurance Plans prepared by the Subcontractors should be in formats consistent with each other as well as with the overall program QA Plan such that the Subcontractors' Plans can be incorporated into the Prime Contractor's plan as appendices. Therefore, it is recommended that the Subcontractor follow the format listed below:

1. Outline for Prime Contractor's overall QA Project Plan, addressing each topic as it refers to your specific operation. See attached sample outline for Subcontractor's QA Plan.

2. Document Control heading (on upper right-hand corner of each page). These may be used as four-line headings, if preferred.

EXAMPLE 1: Appendix Q13, Section 1.1.1
Revision 0
Page of

Subcontractor's
QA Project Plans
Geotechnical Services at Love Canal

Suggested Outline

1.0 Project Description and Organization - include organization chart naming key personnel

2.0 Major Project Elements

3.0 QA objectives - Identify for the appropriate project elements.

4.0 Document Control Procedures - Overall framework, numbering system, etc. has been provided by GCA and described in Section 4.0 of their QA Plan. State your internal operation of the system, identifying your Document Control Officer.

5.0 Chain of Custody Procedures - Overall framework, sample tags, custody forms, etc. are provided by GCA. State your internal operation of the system, identifying the person responsible for custody procedures.

6.0 Project - Specific Internal QC Procedures - State the means you will use to monitor quality including operational checks on instruments when appropriate. Control limits for each operational check should be provided with the corrective action to be taken if control limits are exceeded.

7.0 Data Reporting and Review - Internal procedures to be used should be described.

8.0 Corrective Action Procedures - These corrective actions should have been identified in Section 6.0. State how they will be implemented in your project activity - identify responsible personnel - and how they will be documented.